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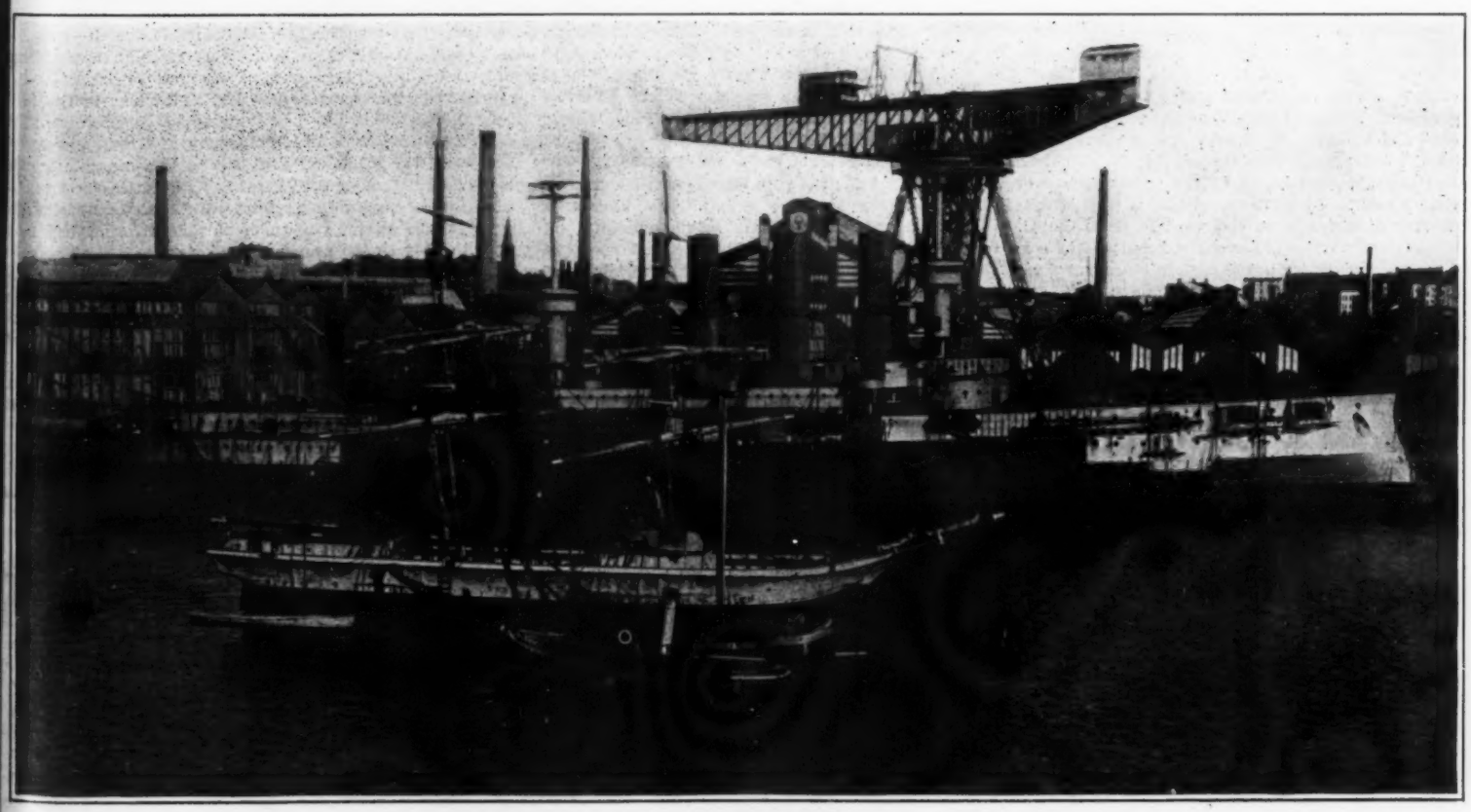
Kiel harbor and the German war fleet.



Krupp shipbuilding and engineering works at Kiel.

KIEL, THE GREAT GERMAN NAVAL BASE.—[See page 234.]

Pioneers of the Army*

A Survey of the History of Military Engineering and Modern Requirements

By Th. Wolff

In the present world war the appliances of engineering are being used to an extent unprecedented in a struggle between nations. Modern warfare has rightly been called a "technical problem," and the technical development of a State is undoubtedly one of the most important factors of its war strength and one of the most essential prerequisites of its success in war. From this general military technology, which furnishes the army with weapons, means of communication and all the other materials of war, is to be distinguished the engineering at the seat of war itself, viz., the activity and technics of the pioneers, which consists in the preparation and arrangement of the battle ground, and which has to fulfill all those technical tasks that are to be performed in connection with the advance of the army upon the enemy, on the battlefield itself. The tasks of this special kind of military engineering spring out of the seat of war, and the troops to which these tasks fall, viz., the pioneers, may be called the real engineers of the seat of war.

Technical tasks, belonging to the service of the pioneers, were necessary in the wars of former times, when, however, military engineering in its present development was hardly even dreamt of, whether in the open battlefield or, particularly, in siege warfare. These tasks were performed in the wars of the oldest warring nations by the soldiers themselves when such individuals were principally employed as were particularly adapted for them by their profession. A kind of special engineering corps is found, for the first time, in the most prominent nation of antiquity, and the most advanced in civilization and warfare, viz., the Romans. In the Roman army system, as also in the later periods of Roman history, there was a special corps of carpenters (*fabri lignarii*) and diggers, or "sappeurs" (*fabri aerarii*), who built roads and fortifications, dug trenches, erected military machines, laid bridges and did all other preparatory work for the advance movements of the army. They were placed under the orders of a general inspector. Many an achievement of these pioneers of antiquity even nowadays still commands recognition. In the military history of the Middle Ages this kind of military engineering was lost. Special engineering troops were not kept in the armies of this period; whenever engineering tasks, such as digging ditches and throwing up trenches and fortifications, had to be performed, help was found in the population of the seat of war, peasants and artisans, who were kept occupied in the camp for a time sufficient to complete those tasks. A somewhat more extended and improved development was given to this system in the German military institutions of the Middle Ages. Then the artillery colonel had to provide the trench-digging peasants for making fortifications, and for building roads and bridges. A captain of the peasant-diggers had the supervision over the men, while actual technical work was conducted by the trench master or a bridge master. With the appearance of guns which, in the first centuries, were less used in field campaigns than in siege warfare, a new siege technique and a kind of engineering service in the modern sense was formed, which naturally co-operated with the artillery. A real military engineering corps, which was employed merely for purposes of siege service and was trained with this in view, was first formed by the famous French general and statesman Supply (1560-1641), whereby the French army was substantially improved. In the armies of other nations also engineering troops were formed following the example of the French. They were trained and, according to the prevailing custom, associated in guilds. But, in addition to these, prominent civil engineers and architects entered the service of the war-making princes as military engineers, and whoever had a reputation in this direction among his contemporaries, was sure to make an advantageous use of his capacities and knowledge in the armies.

During the Thirty Years' war and after, field and fortress engineering corps were formed in European armies and, besides, other kinds of technical troops enlisted. In Prussia, in 1728, under the reign of Frederic William I, a corps was formed from the engineer-officers, which was placed under the command of the fortress engineer Walrawe, then in high repute. The development of military science had, up to that time, mainly progressed in the direction of siege technics (the military engineering science of to-day); but the technique of field warfare, pioneering proper, was given a considerable impulse under Frederick the Great. That famous king recognized with a keen eye the importance and value of a well-developed technical corps for field warfare and took much interest in the training and schooling of his army in this direction. In no small degree were the military achievements of the king against the overwhelming forces of his enemies based upon the much better training of his army. The "Alte Fritz" raised the first and, up to that time, sole pioneer regiment. It was formed in 1742 "in consideration of the coming battles for Silesia with fortresses and impassable countries" and consisted of ten companies of pioneers, one pontoon and one miners company. After about one and one half decades this regiment disbanded owing to strained conditions of that time, although it is still of interest to-day, as a proof of the sagacity of the great king in realizing the importance and value of engineering corps, and as one of the most specialized formations in the history of Prussian militarism, just as, up to the present time, it is the only pioneer regiment known in German military history, since, now, only pioneer battalions exist. Since the days of "Old Fritz" pioneering has been developed into an independent branch of military science.

The formidable technical development during the nineteenth century which incidentally revolutionized, through warfare, a gradual widening of the domain of technical service in armies, particularly by the pioneers. Railways became of importance in the service of the armies and warfare, whereby it became necessary to familiarize the pioneers forming that technical corps which had to be responsible for the technical management of railways, with the new tasks that lay before them. With the entrance of railways into military organization, the pioneers became at once a railway corps, until with the rapidly progressing development of the military railways this combination of pioneer activity and railway service in one corps no longer proved to be consistent with the corp's capacity, operating to the detriment of its general service functions. Consequently, that body of troops entrusted with railway service was separated from the pioneers to form a special railway corps. Likewise, later on, telegraphy, then the telephone and wireless telegraphy, the automobile, airship and flying machine were all taken into the domain of military engineering. These technical departments, too, were originally represented by the pioneers, but when the development progressed in extent and technique to a certain degree, they were separated from the former in order to become an independent branch of arms. In this manner all the technical weapons have had their first use in the pioneer service and have been developed by the latter.

Nowadays the activity of the pioneers in all the larger armies has again been limited to its proper and original domain, viz., field and fortification work for the purpose of preparing the advance movement of the army. This narrower domain has been developed throughout in the last decades and widened by so many technical improvements, appliances and functions, that in spite of this limitation, again there has been some danger of overworking this division of the army service. Until a few years ago field and fortification work was constantly practised in all pioneer battalions and the pioneers trained as "all-round" pioneers for any branch of the pioneer service. Owing to the overworking of the pioneer service which became gradually felt in this combination of field and fortress service, rendering the adequate training of each man in both of these very different branches of service quite out of the question, particularly in the limited service period of two years, the opinion became more and more prevalent that a division of the pioneer troops had become necessary, whereby the construction of bridges and the other parts field-pioneer service was to be separated from the fortress pioneer service. But only the experiences of the Russian-Japanese war laid final emphasis upon this opinion. It was then found that the tasks of siege warfare had become too various and multifarious to be mastered by one and the same corps. In the reorganization of the German army, in 1913, the principle of "all-round pioneers was done away with and a separation of field pioneers from fortress pioneers brought about, the former being placed with the field troops, to perform the technical tasks of field and position warfare, whereas to the latter belong the duties of siege engineers. Counting in the latest additions to the army strength, the German army employs, in time of peace, forty-four pioneer battalions, making about one pioneer battalion to an army corps. Every year, in time of peace, great pioneer exercises are held in the German army and, of course, the pioneer corps participates in the yearly maneuvers, in which is practised the intelligent co-operation of tactical and technical weapons, which alone guarantees success upon the battlefield. In view of the importance of the duties devolving upon the pioneers, modern strategy, especially in the light of the experience of recent wars, particularly the Russian-Japanese war, considerable work has been done for the last years in the training of pioneer troops, so that to-day and in the present war this corps is brought to a degree of efficiency which it never displayed before. In the present war, in which all weapons and all technical means are being used to an extent never dreamt of, and a state of training and efficiency prevails such as has never been seen before, the pioneers as "the fourth arm" stand, with equal rights, alongside the other branches of arms, although they are left far behind as regards numbers. The expressly technical character of this greatest of all wars of the world's history manifests itself in the importance of the pioneer corps, the technical achievements of which contribute to the strength, the battle power and the successess of the other army services, to a degree unprecedented, even approximately, in any previous war.

Engineering at the theater of war presents conditions which the civil engineer, and even the trained pioneer, would not dream of in times of peace; the problems of the field pioneer require the closest adaptation to the most peculiar and unusual circumstances and, at the same time, a far-reaching ingenuity in utilizing materials and their accessories, under conditions that prevail particularly when the stock-materials or regulation equipment of the pioneer corps prove insufficient or unsuitable for the problem at hand. This statement will be amply borne out by a brief survey of the chief activities of the pioneer corps.

First and foremost among the problems of the pioneers is bridge construction, which, at the same time, taxes the engineering efficiency to the utmost. The bridge is the most important avenue of approach to be prepared by the pioneers for the strategic movements of the army. Bridges leading across rivers and other bodies of water, and particularly railroad bridges, are destroyed, whenever possible, by the retreating enemy in order to retard the progress of the pursuers. Bridges destroyed in this manner must be repaired effectively and promptly; often the construction of entirely new passages—sometimes of considerable length—may become imperative. Extraordinary feats in the repairing of destroyed bridges have been accomplished by the German pioneers; in the east as well as in the west they often had an opportunity to demonstrate their efficiency in this difficult domain of military engineering. The construction of bridges is a separate branch of military engineering and has all but become an independent engineering science which, in view of the extraordinary importance of this department, has been fostered by the armies of all countries.

In the German army materials for the rapid construction of military bridges are sent to the front in a state ready for immediate use; such materials make up the bridge-train which constitutes part of the equipment of the pioneer battalions. Each army corps has two division bridge-trains, each containing material sufficient for a bridge about 40 meters in length; in addition, it has a corps bridge-train having at its disposal material for a 120-meter bridge. The entire bridge-materials of an army corps, therefore, are sufficient for a 200-meter bridge, which will furnish a passage across a stream of considerable width. Often much wider streams have to be bridged; this has frequently occurred in the present war. Thus, in the eastern theater of war the Vistula, near which the German army made a very difficult stand against the Russians, had to be bridged repeatedly; for example, near Warsaw, the center of these relentless struggles. Here, in some places, the stream is from 500 to 1,000 meters in width and calls for a supreme effort on the part of the bridge-pioneer. In such and similar cases the bridge-trains of several army corps must be combined; this enables an army to cross even the largest streams ever to be reckoned with. The chief material for bridge-construction consists of pontoons, i. e., boats made of sheet steel which are set afloat upon the stream, a certain distance apart from each other, so that their longitudinal axes coincide with the direction of the river; the approaches from the river banks rest on trestles. Over these pontoons,

* Translated from *Prometheus* for the SCIENTIFIC AMERICAN SUPPLEMENT.

placed side by side, as explained, the bridge-flooring is laid, and consists of balks or girders placed longitudinally, and boards or planks that rest crosswise upon the former. The pontoons must be securely anchored. Anchors, bracing-ropes, cords, balk-lashing, balks, handrails and other materials serving such purposes are also part of the equipment. A military bridge is about three meters wide. Bridges of lighter construction serve as a passage for troops without heavy ordnance; those of stouter construction must be designed to carry heavy siege guns and army trucks, and they should also withstand sudden rush of large masses of troops, such as may be expected in case of sudden retreat or unexpected pursuit by the enemy just as the pioneers carry out the actual construction of bridges, so they also direct the passage of troops; in both cases strict regulations are adhered to.

Pontoon bridges can only be laid across bodies of water that are at least 0.6 meters in depth. When such is not the case, the bridge is built entirely by means of wooden trestles, a task usually calling for high technical efficiency and close adaptation to existing topographical conditions. Destroyed steel bridges, railroad bridges, and viaducts are repaired by similar methods. Special requirements are presented by the construction of new railroad bridges which must also be constructed by the pioneers. Here it is of importance to extend the road and keep it intact in the face of any obstacles or interruptions whatever and thus to maintain railroad communciations which, particularly in the present war, have become most important and constitute such a formidable factor in the plans of the German General Staff. Military railroad bridges are usually wooden structures; pine is used extensively and is either procured from lumber yards maintained for such contingencies or—if such sources be not available—must be cut expressly for the purpose. In such cases civilian labor must often be called upon, which, of course, may be attended by considerable difficulties if the work is to be done in the enemy's country. In building such railroad bridges pioneers and railway engineers usually work together. It may be added that the pioneers build only the larger and heavier military bridges, and such work keeps them more than well occupied. Smaller bridges, on the other hand, so-called field-bridges that serve to bridge smaller bodies of water, ravines and similar obstacles, are built by the regular troops. For such purposes both infantry and cavalry have their own special companies drilled in bridge-building. The equipment necessary for such work is carried along in the train.

However, in some case it may not be feasible to throw a bridge across a river for the transportation of men, horses and war supplies. Various reasons may forbid such a course, and in such cases other means of transportation must be provided, such as rowboat ferries, lighters, flat-bottomed barges, rafts, etc., the building materials for which, just as the bridge materials, are also contained in the corps train, or must be procured at the seat of war. The construction of such means of transportation presents another phase of the pioneer's activities. Another problem is the building of roads. In both theaters of war, the eastern as well as the western, the wretched condition of certain roads serving for the movements of troops gave the pioneers an abundance of work. The repair of existing roads, their maintenance, and the laying out of new roads complete this phase of the pioneer's duties in the field. It is to be understood, of course, that in such work all the other troops will have to do their share; civilians, likewise, may be employed together with the untrained "Landsturm," which renders its military service largely with pick and shovel.

As among the important branches of engineering and pioneer activities in the field we must mention the construction of field fortifications, i. e., the preparation of the ground for offensive as well as defensive purposes. The field fortification is that part of military engineering which, to the general public, usually suggests a maze of trenches. The latter, of course, constitute an important part of such fortifications, but do not exhaust the possibilities by any means. Really any kind of earthworks and, in general, any preparation of the ground for attack and defense may be included in field fortifications which thus are as manifold as they are numerous. Field fortifications may be above ground, such as breastworks, as well as under ground, as trenches, with their system of covers and communications. In the present war the field fortification has been developed and extended to a degree never before approached. They have become real strongholds, under ground fortresses in which the opponents besiege one another for weeks and months. All field fortifications are constructed under the direction of the pioneer corps; the labor in connection with them is performed largely by the other troops. As closely related to these activities we may mention the construction of entanglements which serve to render difficult, if not impossible, the approach of the enemy to the position, and particularly to the trenches. Barbed wire entanglements, abatises made of branches and trunks of trees, trous-de loup, and similar devices may serve this purpose, and may form an obstruction that is practically impregnable, particularly when supplemented by mines and guarded by a sufficient number of outposts. The duty of the pioneers consists not only in constructing their own entanglements as thoroughly and effectively as possible, but also in finding means of destroying the entanglements of the enemy, thereby clearing the way for an assault. This is one of the most difficult and hazardous problems of the pioneer. Under cover of night detachments of pioneers try to crawl up to the entanglements of the enemy and attempt to cut the wires with shears, to fill up the pit-falls or trous-de loup, and to remove the abatises and barricades by blasting. However, the enemy is on guard, and whenever his suspicions are aroused he will direct a furious fire to the point in question, and many a brave pioneer never returns. Unlimited endurance, cunning, and daring in the face of death must be the pioneer's if he shall succeed in reaching the enemy's entanglements and in destroying the obstacles, entirely or in part, thus preparing the way for an infantry assault. When the assault is about to be made the pioneers rush forward, in advance of the others, in order to remove the last obstructions. In case the enemy's entrenchments should be taken, the pioneers must without delay repair, reconstruct, and reinforce the very fortifications and entaglements that they just tried to destroy. In this way they prepare the new position for any possible counter-attacks which, as experience shows, are never slow in materializing.

The pioneer must also be familiar with the work of a building constructor. Whenever a prolonged stay of the troops is to be reckoned with, camp structures of all kinds, huts, closed under-ground shelters, etc., have to be constructed. In such a case a lively building activity becomes noticeable in the field. Such structures will often remind one of the architectural attempts of primitive man, inasmuch as wooden huts of the simplest kind may make their appearance and possibly resemble the first artificial shelters at the dawn of civilization. The camp barracks are always substantial closed sheds, which require much material and labor. Their size and general dimensions are governed by the number of men to be taken care of. Stoves and chimneys must be provided; also devices for the disposal of rifles, knapsacks, etc. Any further accessories, such as home-made furniture, blankets, etc., and other things making for comparative comfort are usually provided by the men themselves. Systems of water supply for man and beast, as well as shelters for horses, windscreens and the like, must also be built by the pioneers. In all these building activities it is not so much the erection of the structure as the supply of the materials necessary that may cause difficulties. Such is particularly the case when there are no forests in the vicinity that may yield suitable lumber. It then becomes necessary to resort to the laborious and time-consuming method of procuring materials by means of trucks and transports, often over great distances. Under such conditions an effort is made to prepare the lumber at the source, as much as possible, so that the parts are merely to be assembled at their destination. Of course, the pioneers must also be familiar with the dressing of the raw materials; hence, hand saws and even sawing machines are always in evidence.

We may see, therefore, that the task of the field pioneer in the present gigantic struggle in Europe is enormous indeed. A sum total of engineering work is being done which the peaceful, salaried engineer at home would not even dream of, and which calls for the greatest possible versatility and ingenuity, and for an adaptability to the most unusual conditions, and often requires the ability to perform feats with the most primitive means; in short, a maximum of excellence that is truly marvelous. In the course of the present war the German pioneers have thus far been able to solve their numerous problems with credit, in spite of many handicaps. And although their activities are perhaps less spectacular than those of the fighting troops, and much less attract the attention of the public, it is true, nevertheless, that the pioneers are entitled to an eminent share of the success of the German troops.

Steel and Civilization*

In delivering two lectures on "The Evolution of Steel: Influence on Civilization," at the Royal Institution on the first two Tuesdays of June, Prof. J. O. Arnold, F.R.S., took a historical line, going back to the stone, bronze, and wrought-iron ages, and making special reference to the part taken by Sheffield in the development of the steel industry. Steel, Dr. Arnold emphasized, had become the most powerful agent both of civilization and of destruction.

Having illustrated the significance of the iron and steel development, chiefly by referring to bridge construction, Dr. Arnold remarked that England had been supreme in the metallurgy of iron and steel in the early eighties, when it had produced 8,000,000 tons of pig and 2,000,000 tons of steel per year, while America and Germany had hardly counted. At present the annual steel production was in round numbers: America, 28,000,000 tons; Germany, 14,000,000 tons; England, 7,000,000 tons. America had obtained the lead because its 92,000,000 inhabitants wanted steel for railways and works and had all the resources needed, while Germany owed its success to the appropriation of the brains of British inventors, and notably of the Thomas-Gilchrist process. There was a brighter side to this comparison, however; for England was still leading in the supreme quality of her steel, thanks largely to the work of men like Sorby, Prof. Arnold's predecessor in the chair of metallurgy at Sheffield.

The researches of Gore and Barrett on recalescence, and of Osmond, had unfortunately led to the allotropic theory of the hardness of steel, which had, the lecturer considered, become a curse to the metallurgy of steel, as the old phlogiston theory had been to chemistry. The following observations of Dr. Arnold were made to show the untenability of the theory. The cooling curve of the purest electrolytic iron of Hicks and O'Shea had given the usual recalescence peak at 900 deg. Cent., which seemed to be due to some molecular change (akin possibly to that which water underwent at 4 deg. Cent., when showing its greatest density), and two other smaller peaks, above which iron was not magnetic; very little was known beyond this, but the points had nothing to do with α, β, γ iron.

Further, Prof. Arnold stated that he had heated a very pure iron (0.07 per cent of carbon), and quenched it in cold brine at 15, 400, and 928 deg. Cent. That quenching should have preserved the allotropic hard modification; but the maximum stress had been found to be roughly proportional to the absolute temperatures; the reduction in area had remained about 76 per cent throughout, and the elongation had gone down from 44 to 30 and 21 per cent; these properties had, hence, nothing to do with the critical temperatures. Hardness, he agreed with Sir Robert Hadfield, depended on carbon, and on nothing else. Many of the tables which Prof. Arnold exhibited illustrated further progress in tool steels and other steels, on which he had lectured in the same place two years ago.

Four hard steels should, Prof. Arnold considered, be distinguished—namely, iron steel, tungsten steel, and vanadium steel, to which he hoped to add molybdenum steel at the autumn meeting of the mechanical engineers. These four steels formed members of one class, though they had their characteristic microstructures and differed enormously in properties; thus the range of formation of iron hardenite was 32 deg., and that of tungsten hardenite 250 deg., starting at 1,300 deg. Cent.

Touching upon testing, Prof. Arnold uttered a warning against the low factor of safety which engineers accepted for nickel steel—2.25. The estimate was based upon the elastic limit; but by slow cooling a steel might be annealed to death, and have no safety left. The yield-point, on the other hand, might be raised by cold work to satisfy the engineer, and yet such bolts would break.

* From *Engineering*.

Manjack Deposits in the West Indies

There are in the island of Trinidad large deposits of manjack, especially in the San Fernando section, where are situated the Vistabella and the Marabella properties. During the past decade approximately 18,000 tons were exported in a crude state.

In outward form and general appearance manjack is not unlike fine coal, and is essentially a bituminous substance. It is an oil residuum occurring in lenticular seams between walls of peculiar clay, which appear to have absorbed the oil under very heavy pressure. It is jet black in color and resinous in its nature, and has long been known for its insulating properties in the manufacture of electric coils, dynamos, and generators.

It appears that the Vistabella manjack properties are worked under a long lease by an American company, which, besides exploiting and exporting manjack in its natural state, has undertaken the manufacture of certain well-defined compounds. One of these is a high-grade black manjack paint for use on smokestacks and on boilers, both inside and out; another is a preparation suitable for greasing pipe threads, dressing wire rope, etc.

Barbados manjack is of two varieties—the conchoidal and the columnar. The first is the more valuable, and a newly-fractured specimen cannot be distinguished from jet, so far as outward appearance is concerned. *Journal Royal Society of Arts.*

The Scissors Periscope

Devices for Making Observations from a Safe Cover

GERMAN army officers are making extensive use of the ingenious instrument shown in Fig. 1, which is called the scissors periscope, because it comprises two hinged tubes and can be opened and closed like a pair of scissors. Each tube carries an object glass at its upper or outer end. The rays coming from these object glasses are reflected by prisms to binocular eye-pieces at the lower or inner end of the large tube to which the movable tubes are hinged, so that each eye of the observer sees only the view which is presented to one of the objectives. Hence, the eyes are virtually separated as widely as the objectives, and the perspective effect is correspondingly increased. With the usual magnifying power of ten diameters, a very sharp picture of the observed object or field is obtained. The instrument can be used in a horizontal position, opened just wide enough to embrace a tree or other object which conceals and protects the observer. It may also be used in a vertical position with its objectives protruding above a wall, bank or trench, which affords cover to the observer. A mounted officer carries the scissors periscope by means of an attachment to his saddle. The periscope is often mounted on an observation motor car, provided with a shield for the observer, as shown in Fig. 1. Larger and more powerful instruments, called tower periscopes, protected by armor, are employed in fortifications. In Fig. 2, we see an officer using a short and ingeniously masked scissors periscope, which apparently lacks the common large tube. In this form the instrument appears identical with the Zeiss relief periscope, which was described and illustrated in the SCIENTIFIC AMERICAN SUPPLEMENT of May 22nd, 1915.

Fig. 1.—A scissors telescope mounted on an observation car.

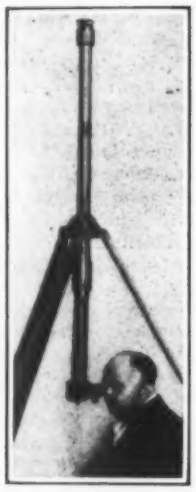


Fig. 3.—Panoramic telescope of periscope type.

Two other novel military field glasses are illustrated in *Ueber Land und Meer*, from which this description of the scissors periscope is reproduced. The panoramic periscope (Fig. 3) resembles the panoramic periscope of some submarines. It gives the concealed and sheltered observer an enlarged panoramic monocular view of the surrounding landscape, from a considerable elevation. Fig. 4, shows the panoramic lens at the top of the tube, and Fig. 5, shows the ring-shaped picture presented to the observer.

The mirror periscope, or trench periscope, is simply an ordinary field glass stuck into the side of a long and narrow wooden box containing two inclined mirrors. It enables an observer in the trenches to see over the parapet without exposing his head, as shown in Fig. 6. This simple device has saved many lives.

Fig. 4.—Top of panoramic telescope showing the lens.

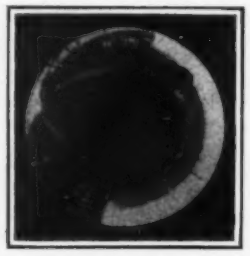


Fig. 5.—View of a city as seen with the panoramic telescope.

Prizes for Scientists

A HAPPY idea for some new and simple contrivance that is really needed often means a fortune to the inventor. But apart from the purely commercial side of the question there are many thousands of dollars in prize money waiting to be claimed by inventors and discoverers. The prizes are offered by various organizations in the United States and Europe, the money having been voted from the funds of the society or left by will for the encouragement of research.

The most generous amounts are offered for industrial inventions. For example, the International Association of Recognized Automobile Clubs is prepared to give no less than £20,000—about $96,000—to stimulate research in gasoline substitutes. Moreover, they will lay no claim to the patent rights, which is an important consideration. If the conditions are a little difficult to meet, the prize at least is worth trying for. The new fuel must be suitable for use in existing internal-combustion motors, must be available in sufficiently large quantity, and must be incapable of monopolization by a trust.

And if, after winning the above prize, it is found that the new fuel can be manufactured profitably in Great Britain, the inventor can pick up another two thousand guineas ($10,080) from the British Society of Motor Manufacturers and Traders.

Then there is a handy litt'e sum of $1,200 waiting for anyone who can make coal waste into briquettes in a more economical manner than is possible at present. This prize is offered by the Government of New Zealand.

From the time of Sir Humphry Davy many safety lamps have been invented for the use of coal-miners. There is room, however, for a still better electric lamp, combined with a reliable device for detecting and giving warning of dangerous gases in the atmosphere. To the inventors of such a lamp $5,280 will be given by the Mining Interests of the Dortmund District in Germany.

A RADIO TO THE PLANETS.

Apart from the Nobel prize for services rendered to the cause of peace, which this year will probably go to the German Emperor (*sic*), there are a number of useful amounts, both large and small, offered for scientific research.

Can you send a message to Mars? If so, you are well on the way to win the Pierre Guzman prize of a hundred thousand francs ($19,300), offered by the French Academy of Sciences. This sum will be awarded to anyone who can devise a satisfactory method of ringing up our neighbors on the planets. Mars itself, however, is barred. But there are still five large ones left, to say nothing of hundreds of tiny ones, as asteroids, between Mars and Jupiter.

Here is a chance for a mathematician. Most people who have learned algebra at school will have heard of Fermat's Theorem. This is to the effect that in the equation $x^n + y^n = z^n$, if n stands for an integer (whole number) greater than 2, no integral values can be found for x, y and z. A partial proof has been suggested, and part of the interest on the money has been awarded, but so far no general proof has been forthcoming. The mathematician who can provide a general proof, true for any numerical values that can be given to the letters, will carry off the Wolfskehl prize of $21,600, held by the Academy of Sciences of Goettingen, Germany. There is no hurry. Any time up to September 1st, 2007, will be soon enough, and the war will probably be nearly over by then.

Fig. 2.—A masked scissors telescope.

By the way, it is not necessary to have a university education in order to do good work in mathematics. Fermat himself, the originator of the above theorem, was quite a humble individual. He was a tax collecter, who studied mathematics in his spare time as a hobby.

The Jean Reynaud prize is given every five years by the Paris Academy of Sciences for the best original work in mathematics. It amounts to £10,000 ($53,200). Another prize offered every five years is a sum of money, varying in amount, given by the Royal Society of Sciences and Arts of Gothenburg, Sweden, for an important scientific discovery.

Numerous small grants, as well as one large one of $20,000, have been made from the Pollock fund for promoting the invention of appliances to save human life at sea. The money is held by the Conservatory of Arts and Trades of Paris, and there is still about $30,000 left.

Fig. 6.—Construction and use of the French periscope.

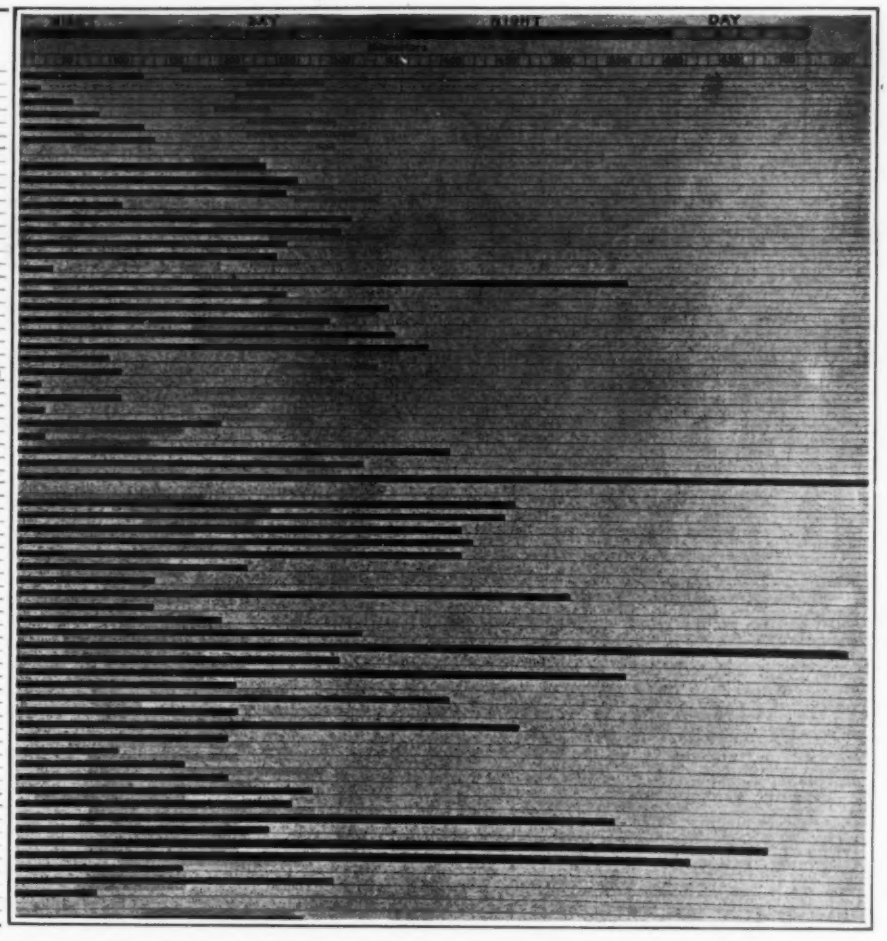
German officers watching the effect of their gun fire.

The Use of Balloons During the Siege of Paris, 1870-1

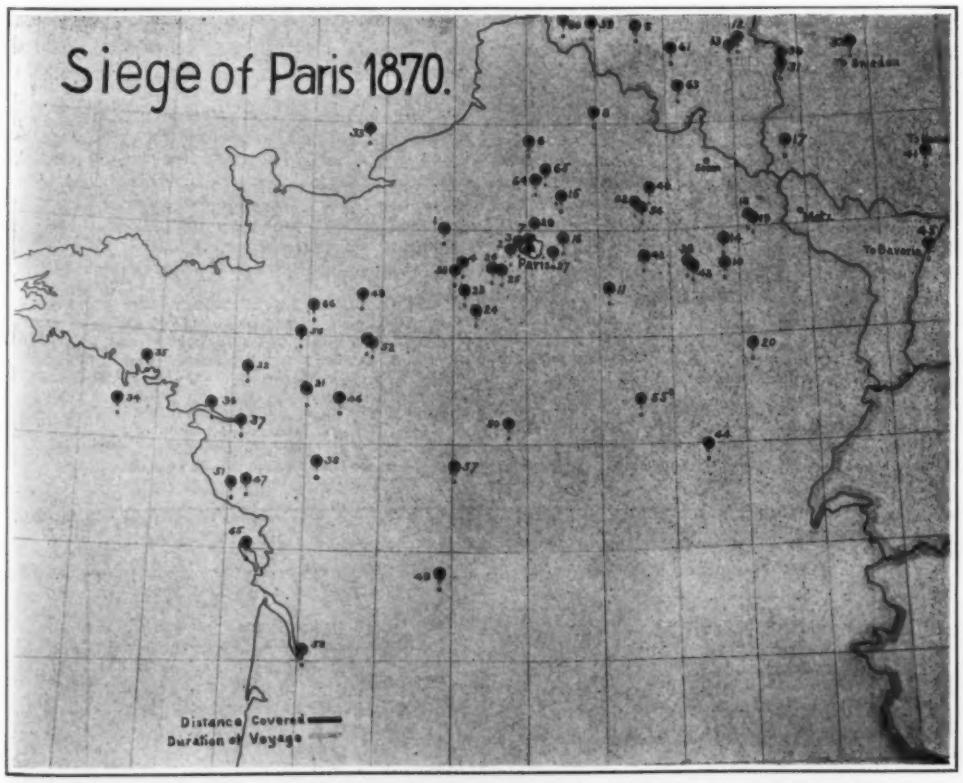
Table and Charts Showing Number of Ascensions and Results

Number.	Date of Ascension.	Names of Balloons.	Pilot.	Cubic Meters.	Passengers	Pigeons	Mail, in Kilos	Direction of Wind	Remarks.
1	23 Sept.	Neptune	Jules Durouf	1200	—	—	125	0	
2	25 "	Ville de Florence	Gabriel Mangin	1400	1	3	150	0	
3	24 "	Les Etats Unis	Louis Godard	1340	.	4	75	SO	Two Coupled Balloon
4	30 "	Le Celeste	Gaston Tissandier	700	—	2	100	0	Pilot Injured
5	7 Oct.	Armand Barbes	Trichet	1200	2	16	100	S	Gambetta Injured
6	7 "	George Sand	Revillon	1200	3	18	——	SSO	
7	9 "		Racine	12	2	—	——	S	
8	12 "	Washington	A. Berteaux	2045	2	25	3.0	SSW	Pilot Injured
9	12 "	Louis Blanc	Farcot	1200	1	8	425	SSW	
10	14 "	Godefroy Cavaignac	Godard pere	2045	3	6	200	W	Passenger Injured
11	14 "	Cristoph Colomb	A. Thuandier	2045	2	10	300	WNW	
12	16 "	Jules Favre No. 1	Petit L. Godard	2000	3	6	200	SW	
13	16 "	Jean Bart	Labadie	2045	2	4	300	SW	
14	18 "	Victor Hugo	Nadal	1200	—	6	440	SW	
15	19 "	Le Lafayette	Josse	2000	2	6	300	SW	
16	22 "	Le Garibaldi	Jgheins	2000	1	6	450	W	
17	25 "	Le Montgolfier	Herve-Sepe	2045	2	2	200	W	
18	27 "	Le Vauban	Guillaume	2000	2	22	270	W	
19	27 "	La Normandi	Rene-Guzon	1650	3	—	300	W	Capture.
20	29 "	Colonel Charras	Gilles	2000	—	6	460	WNW	
21	2 Nov.	Le Fulton	Gloennec	2045	1	6	350	NO	Pilot Mortally Wounded
22	4 "	Le Ferd. Chiton	Lehnet Vital	2000	2	6	150	NO	
23	4 "	Le Galilee	Husson	2045	2	6	400	NO	
24	6 "	La Ville de Chateaudun	Rose	2000	—	6	500	NO	Pilot & dispatches captured
25	7 "		Piper	1200	2	—	——	NO	
26	8 "	La Gironde	Gallay	2045	3	3	60	O	
27	12 "	Le Daguerre	Lhuiert	2045	2	20	260	WSW	
28	12 "	Le Niepce	Pagnao	2045	4	—	500	W	Captured
29	18 "	General Ulrich	Lemoine pere	2045	3	34	80	SW	
30	21 "	L'Archim. de	Euffet	2045	2	5	200	SSW	
31	24 "	L'Egalite	W. de Fonvielle	2000	4	12	——	SW	
32	24 "	La Ville d'Orleans	Roller	2000	1	6	200	SW	
33	28 "	Le Jaquard	Prins	2045	—	—	250	SO	Drowned
34	30 "	Jules Favre No. 2	Martin	2000	1	10	100	ONO	Pilot Injured
35	1 Dec.	Le Battaille de Paris	Poirrier	2000	2	—	——	ONO	
36	2 "	Le Volta	Chapelain	2045	1	—	200	ONO	
37	5 "	Le Franklin	Marcia	2045	1	6	100	ONO	
38	7 "	L'Armee de Bretagne	Surel de Montchamps	2000	1	6	400	SO	
39	7 "	Le Denis Papin	Donalain	2045	3	3	60	ONO	
40	11 "	General Renault	Joignerey	2000	2	12	100	SSO	
41	15 "	Ville de Paris	Delamarne	2000	2	12	70	WSW	Captured
42	17 "	Le Parmentier	Paul	2045	2	4	140	W	
43	17 "	Le Guttemberg	Ferruchon	2050	2	6	——	W	
44	18 "	Le Davy	Chaumont	1200	1	—	50	NW	
45	20 "	General Chanzy	Verrecke	2000	2	4	25	W	Captured
46	22 "	Le Lavoisier	Ledret	2045	1	6	175	NO	
47	23 "	La Delivrance	Gauchert	2050	1	4	110	NO	
48	24 "	Bouget de l'Isle	Yahn	2045	2	—	——	O	
49	27 "	Le Tourville	Rontet	2050	3	4	100	S	
50	27 "	Le Merlinde Douai	Tarbe des Sablons	2000	1	—	——	S	
51	29 "	Le Bayard	Regnenet	2045	1	4	110	NO	
52	31 "	L'Armee de la Loire	Lemoine fils	2000	—	—	250	NO	
53	1 Jan.	Le Newton	Ours	2045	1	4	310	ONO	
54	9 "	Le Duquesne	Richard	2045	3	4	150	WSW	
55	10 "	Le Gambetta	Ch. Duvivier	2000	1	3	240	SW	
56	11 "	Le Kepler	Roux	2045	1	3	160	ONO	Pilot Injured
57	13 "	Le Monge	Raoul	2045	2	—	——	NNO	
58	13 "	General Faidherbe	Van Seymortier	2000	1	5	60	NNO	
59	15 "	Le Vaucanson	Clarisse	2045	2	4 dogs	75	S	Dogs did not return
60	16 "	Le Steenacker	Vibert	2000	1	—	*	SSW	
61	18 "	La Poste de Paris	Turbiaux	2000	2	3	70	SW	
62	20 "	General Bourpaki	Th. Mangin jun.	2000	1	4	125	WSW	Pursued, burnt
63	22 "	General Daumesnil	Roblin	2050	—	3	280	SW	
64	24 "	Torricelli	Roly	2045	—	3	220	S	
65	27 "	Richard Wallace	Larose	600	—	3	220	SO	Drowned
66	28 "	General Cambronne	Tristan	2045	—	—	20	ONO	

*2 Boxes of Dynamite.



During the siege of Paris by the Germans, from September 23rd, 1870, to January 28th, 1871, sixty-six balloons were sent up from the invested city, mostly for the purpose of carrying mail and dispatches, for which purposes they were found quite valuable. These balloons carried a total of 164 passengers, 381 carrier pigeons, 5 dogs (for experimental purposes) and 10,675 packages of postal matter. The above table and chart gives a detailed list of these ascents, and shows the distance traveled in each case.



This chart shows where each of the balloons sent up from Paris, during the siege of 1870-71 landed, the numbers in each case corresponding to those given in the list shown above.

The First Spanish Submarine

THE first Spanish submarine was built by Monturiol at Barcelona in 1865. Submarine navigation, now an accepted fact, was at that time considered impossible, even by scientific experts, and the "Ictineo," as this boat was named, was built primarily to refute that idea.

The crew consisted of five men, to whose control the submarine responded perfectly in every respect. At one trial it remained submerged for 2½ hours, and ran 2,000 meters in a fixed direction, keeping below the surface.

After numerous tests of this boat at Barcelona and Alicante, a seond "Ictineo" was built. This boat being larger and better equipped and having the experienced crew of the former boat, the results of the trials now assumed a real scientific value. The boat was first tried on June 16th, 1865, to determine the impermeability of the hull, which kept intact until 23 meters deep. At this point, 252 liters of water gained admission in 3 minutes through an opening caused by oxidation of some iron screws, which were used alternately with brass screws in the construction of the sheathing.

Attention was next given to the effect of continued submersion on the air inside the boat. Although 1 per cent of carbonic acid was considered dangerous, they remained breathing this quantity for ¾ of an hour, and in 1¾ hours more a sense of asphyxia was felt, the air then containing 3,035 per cent of carbonic acid. Attempts to determine the effects of shortage of oxygen were interferred with by troubles with the motor. Trials with artificial air gave excellent results, and at the end of 2 hours submersion no effects were noticeable.

The boat carried a cannon of 10 centimeter bore and 60 centimeters long. This gun could be rotated on its trunnions, and loaded and discharged with the boat submerged. To show the military value of the submarine, many manœuvers were executed, such as descending to a depth of 12 meters, loading the gun, rising to within 90 centimeters of the surface and firing. One kilo of powder discharged at this depth sent a column of water 10 meters high into the air.

Throughout all these tests much difficulty was experienced with the engine, which worked by steam; also by the narrow limits of the boat. The engine had to be capable of separation into pieces small enough to pass through an opening 54 centimeters in diameter, which was the only means of access to the interior of the boat. The entire internal space of the boat was only 29 cubic meters, which barely sufficed for the engine, controlling mechanisms, oxygen generator, ballast boxes, crew etc., Tests were made with the engine to determine the advantages or disadvantages of petroleum, hard coal, or coke as a fuel, and the advantages of forced draft.

All these trials had cost dearly, and Monturiol now came to the end of his resources. The "Ictineo" was finally broken up and sold as junk by his creditors, in the presence of the inventor.

Natural History of the Whale Shark—I

Facts About a Monster Fish That is Little Known

By Prof. E. W. Gudger, Ph.D.

In June, 1912, while a guest of the Marine Biological Laboratory of the Carnegie Institution of Washington at Tortugas, Florida, one of the laboratory men brought me a copy of the *Miami Metropolis*, giving an account of the capture of some great fish near that city, but as the descriptions of the animal were very defective, it was impossible to decide what it was. On the whole, however, since all descriptions said that it was enormous in size and marked with white spots, I finally concluded that it was probably an Orca, or Killer Whale.

Toward the close of the following month (July), in passing through Miami on my way north, I had an opportunity to see the skin of this huge animal, and to talk with its captor, Capt. Charles Thompson. At this time I had no knowledge of the Whale Shark save an indefinite recollection of a picture of one and certain statements as to its great size and its occurrence on the east coast of Africa, found in *Holder's Zoology*. However, the shagreen-like skin and the strap-shaped gill-slits, plainly showed that it was a shark.

This skin, which was the most enormous thing of the kind that I had ever seen, was hung over a long, wooden support, in a house built to receive it on the bank of the Miami River. Despite the fact that the skin had been cut and torn by harpoons and bullets, and had suffered much at the hands of the gang of men which Capt. Thompson had help him skin the fish, it was in fair condition and in the hands of a good taxidermist was capable of making a fine mount.

The general color of the skin was brownish with large pale, white spots, perhaps as large as a silver dollar. No longitudinal bars, such as will be described later, and no short transverse markings, were noticed. The spread of the tail fin was so great that a tall man could stand under the tip of the upper lobe. The mouth and jaws, which had been cut out with the skin, were very large, so large that a man could have gotten within them. The teeth, which were in a band about two inches wide in each jaw, were very minute, prickle-like, recalling forcibly the old-fashioned "wool cards." Capt. Thompson emphasized the fact that "the fish had no bones," save the backbone, a number of segments of which he showed me. These were cartilaginous, about five inches in diameter, bi-concave in form, and were of a yellowish-brown color, apparently due to the oil contained in them.

The mounting of the skin was a Herculean task, and was only done after some months' incessant labor.[1]

In the *Bulletin* of the New York Zoological Society, for November, 1913, Dr. C. H. Townsend wrote very interestingly of this Whale Shark, and gave two figures, one of the mounted specimen and one of the fish taken shortly after its capture. The latter, showing a man crouching in the mouth cavity, gives an idea of its enormous size. It is reproduced herein as Fig. 2.

I ascertained that, at the time of the capture of this shark, Capt. Thompson's boat was chartered by Mr. Charles T. Brooks, of Cleveland, Ohio. After some difficulty, I succeeded in getting in communication with Mr. Brooks, and am indebted to him for the following excellent and invaluable account of the capture.

"I had engaged Capt. Charles Thompson, of Miami, and his boat 'Samoa,' to go south along the coast from Miami for tarpon in the latter part of May, 1912. We finally anchored just below Knight's Key, about one half mile inside from the old Florida East Coast dock. One morning the Captain saw the tail of a large shark, as he supposed, within a few feet of the viaduct. He asked me if I would like to see a shark harpooned, and I said that I would. He then began to be impressed with the idea that this was the largest shark he had ever seen. We immediately took the launch and row-boat attached to it, and started to the fish which was then moving slowly along with its tail above water, parallel to the viaduct and only a few feet from it. The Captain shouted to a man on top of the viaduct, asking him if he had seen the shark. He replied that he had seen it, but that it was not a shark—and that he did not know what it was, and that it had been around there for three or four days. We approached closer, and finally the boat was right over the fish, and we could see his spotted back three or four feet feet below the surface. We were in this position when Capt. Thompson threw the harpoon. The fish was harpooned at about half past nine in the morning. We called to our aid some fishermen who happened to be near with their boats, and with their help, succeeded after a while, by means of a sharp hook thrown over the fish's nose, in getting his body nearer the surface of the water, and from time to time, during the day, shot him in the back, perhaps forty or fifty times with a rifle. We tried shooting him with a shotgun with No. 2 shot, at a distance of perhaps two feet from his back, but the shot bounded off, leaving their impression in a circle of about an inch and one half or two inches, for the depth of perhaps an eighth of an inch in his back.

"The fish circled several times in from the viaduct, perhaps half a mile, coming back again to the viaduct, and at one time when the tide was running rapidly out about one o'clock in the afternoon, we thought that he might go outside. The boats were carried by the tide outside the viaduct, but the fish remained inside and finally started further inside and made another circle.

"I was surprised that the fish did not put up any fight. He proved to be a sluggish monster, and seemed to fail to realize that anything particular was happening to him. He kept circling in his slow way, moving his tail, which was always above water, in an arc of about eight to ten feet, in a slow, regular fashion, drawing the several boats after him with great ease. There were several harpoons in him, and one line was fastened through his tail and another to the dorsal fin.

"About half past five o'clock at night, he made his last circle in from the viaduct, and was directed over toward a sand-bank by poking his head with a boat hook; he finally stranded on the sand-bank, and several lines, one around his body, were made fast to our oars and boat-hooks stuck deep in the sand of the bank. A piece was then cut out of his head and with a knife, attached to a pole, it was sought to reach his brain and kill him. We were surprised to find about three inches of gristle at this point in his head.

"I had his measure taken while in the water on the bank, and he measured thirty-eight feet. A 20-foot line put around his body for the purpose of anchoring him to the sand-bank, lapped over about two feet, so that we judged that he was about eighteen feet in circumference. His weight was pure estimate, but we thought he would weigh something over five tons.

"Next morning, which was Saturday, we brought the 'Samoa' up alongside, and lashed the fish to the side and started for Miami. That evening we reached a point opposite Railroad Camp, and went ashore to telegraph for a tug, and some of the railroad boys were very much interested in the catch. They thereupon, the next morning, which was Sunday, came out on a railroad tug, perhaps a dozen of them, and one of them took the pictures which are inclosed. We started on our journey to Miami and on Sunday afternoon, were met by the tug and finally reached Miami about four o'clock Monday morning.

"The color was rather a mouse color, covered with yellow spots two or three inches in diameter, which were generally located in parallel lines of yellow, running from the backbone down each side. This marking is to some extent shown by the photographs. Underneath the color was yellow."

Fig. 2 shows the Whale Shark, which had been hauled up alongside the yacht. Of especial interest are the enormous mouth in which a grown man is crouching, the small nasal apertures—the left one being immediately over the man's head—and the small eye immediately posterior to the angle of the jaw. This is one of the figures given in Dr. Townsend's article. This picture, together with a number of others, was taken by Mr. Joseph N. Beck. Mr. Brooks has sent me copies of all these photographs and through his kindness, I am able to give this picture and the two following.

Fig. 3 gives an idea of the great size of this Whale Shark, for the tip of the tail may be seen just under the bow of the launch in the background of the picture. Note also the great size of the dorsal fin, and likewise the short transverse bars on the sides of the back. However, these are much better shown in Fig. 4. Attention is also called to the first and second dorsal fins, and the upper lobe of the caudal, all of which are spotted.

With no small difficulty, even when aided by a tug, the great shark was finally brought to Miami. Here it was put on a marine railway and hauled up out of the water, but its weight (estimated at 5 tons[2]) was so great that it broke the timbers of the railway. Fig. 5 is from a post-card presented me by Capt. Thompson, showing this huge creature after it had been hauled out of water. In the right lower jaw, the band of teeth is plainly visible, and the nasal orifices and flaps are well shown. The left eye is in perfect focus, as are the spots which on the head are more numerous but smaller.

Back of the eye, and only about one half the distance of this from the angle of the mouth, as it appears in Fig. 5, may be seen the comparatively small spiracle which is here about three times longer than wide. It can also be made out on Figs. 3 and 6. Back of the spiracle lie the enormous gill-slits which are also shown most plainly in Fig. 5.

Fig. 6 is made from a photograph of the mounted skin. Compared with Figs. 3 and 4 made from photographs of the shark in the fresh condition, it would seem that the spots are too large. On the skin, when seen by me in late July, 1912, the spots seemed about the size of a silver dollar, and were even then fading markedly.

It is a source of keen regret that I have not been able to examine this mounted specimen.

HISTORICAL.

On a morning in April, 1828, some fishermen in Table Bay, Cape of Good Hope, South Africa, saw swimming leisurely around with its dorsal fin above water a large shark of unusual coloration. This was easily secured with the harpoon, since it offered comparatively little resistance, and was brought to shore where, fortunately for science, it fell in the hands of Dr. Andrew Smith, surgeon to the troops stationed in South Africa. Thus there came to the knowledge of the world the largest and in many ways the most interesting of the shark tribe.

During the following year (1829), Smith named his shark *Rhincodon typus* (evidently a misprint for *Rhincodon*), and gave a preliminary description of it as follows:

"Teeth slender, short, gently curved, so disposed in longitudinal rows that they have the form of a band in the front part of the maxilla and likewise in the similar part of the mandible; head wide, depressed, squarish, mouth at front of and almost as wide as the head; sides with longitudinal ridges and a very distinct keel on each side of the tail; a spiracle just behind each eye; anal fin almost opposite the second dorsal fin.

"Above, greenish-gray, with spots and numerous white lines; beneath, reddish-white, changing to red; with a dorsal keel before its anterior dorsal fin; behind, round, thence flat.

"Color of back and sides greenish-gray, with numerous white spots, varying in size from that of a sixpence to a half penny; also several white lines on the sides of the head, the body, and about the branchiæ; below, reddish-white, passing into vermilion red, anterior part of back carinated, posterior rounded or flat. Length of the specimen from which the description was taken, 15 feet; greatest circumference, 9 feet. The skin was purchased for £6 sterling, and forwarded to the Paris Museum."

[1] It may be noted here that in preparing the skin nearly half a ton of shavings was removed from it.

[2] This estimate is Mr. Brook's, while that of Capt. Thompson is three times as great. However, there is possibly a better way to get at it and that is by the fisherman's ancient formula, which I copy from C. F. Holder. This is that the length in inches multiplied by the square of the girth in inches and the product divided by 800 will give the weight in pounds. Taking the length at 38 feet (456 inches), estimating the girth at 18 feet (216 inches), and performing the operations designated, we get 26,594 pounds, or 13¼ tons for the weight of this giant shark.

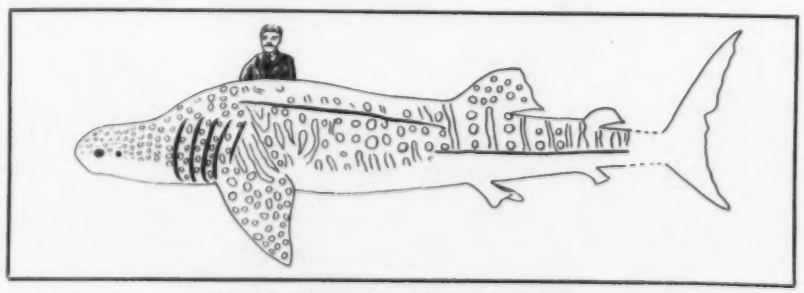


Fig. 7.—Lateral view of R. Pentalineatus

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In 1841, Müller and Henle in their great "Systematische Beschreibung der Plagiostomen," give our fish a definite place under the name *Rhinodon typicus*. Their description is based on Smith's paper of 1829, and upon the dried skin in the Paris Museum. However, they give us one bit of information which Smith omitted, even from his second paper presently to be considered. They say: "The masculine appendages are in the single specimen small and do not extend backward past the hinder edges of the ventral fin."—i. e., this specimen was an immature male.

In 1849, Smith, in his "Illustrations of the Zoology of South Africa," published an elegant figure of our shark, which is reproduced herein as Fig. 1. He also redescribed the external features of the fish in the following words:

"Color.—The upper and lateral parts of the head and body dull lavender-purple, shaded with brownish-red; the under surface of the head, the sides of the body inferiorly, and the belly, light wood-brown, tinted with flesh-red, which tint is very strong on the anterior portion of the head and the hinder edges of the fin. On the upper and lateral parts of the head and body, and also on several of the fins, the ground-color is much broken by a profusion of small, circular white spots, and a great number of narrow vertical lines, which commence at the center of the back and terminate at the belly. The spots are smallest and most numerous on the head and upper surface of the pectoral fins, on the other parts they are larger and more scattered; and on the caudal fin they are arranged in a single row close to its upper edge; the second dorsal, the anal, and the ventral fins are without spots. Eyes—coppery-red.

"Form, etc.—Head broad, depressed and somewhat wedge-shaped, the mouth opening directly in front; teeth small, recurved, closely congregated, and disposed in a broad, transverse belt along the inner surface of each jaw, immediately inside the lips; eyes lateral and situated almost directly behind the angles of the mouth; pupil transversely oval; temporal orifice about three-fourths of an inch in diameter. Vertical section of the body, in front of dorsal fin, somewhat triangular; and the back, between that fin and the middle of the hind head, slightly arched and strongly keeled; back, posterior to the dorsal fin, flat and depressed. Sides of body, irregular from two distinct longitudinal keels, which commence together a little in front of and considerably above the upper extremity of the first brachia, and recede a little from each other as they proceed backward. Of these, the lowermost pursues a waved direction, and at last is lost in, or coalesces with, the keel on each side of base of caudal fin; the upper again pursues a more direct course, becomes forked posteriorly, and both its branches terminate under and anterior to the second dorsal fin; the keel on each side of the tail very strong and thin at the outer edge. At the base of the upper lobe of the caudal fin, there is a transverse groove, to admit of the ready elevation of the fin, a power so necessary to direct the course of the fish in swimming. The first dorsal fin, posteriorly, is deeply emarginate, and the second dorsal fin has its inferio-posterior angle prolonged into a slender sharp point. Pectoral fins large, and their hinder edge, toward its base, with a distinct, large, triangular elongation. Ventral fins very small, and directly below the hinder portion of the first dorsal; anal fin also small, quadrangular, and with its superio-posterior angle prolonged into a point, its anterior angle directly under the hinder extremity of the base of the second dorsal. Caudal fin deeply forked, the upper portion larger and much longer than the lower. Branchiæ slightly waved, the first and second much the longest, and, together with the third, are in front of the base of the pectoral fins; the fourth and fifth are directly over it."

We next hear of our great shark in a letter sent from Dr. Buist in Bombay, to Col. Sykes in London, and published in *Proceedings* Zoological Society of London, 1850. Dr. Buist[1] in describing shark fishing at Kurrachee in Northwest India, west of the mouth of the Indus River, speaks of the capture of the "Great Basking Shark or Mhor," a giant shark "often 40, and sometimes 60 feet in length." Here the spots are not mentioned, but, as there is no record of *Selache maximus* being found in the Indian Ocean, we must conclude that *Rhinodon* is referred to. So think most of the writers on this fish.

Our next reference, however, is to a gigantic shark so well described that there can be no doubt as to its identity. Capt. James Steuart in his "Notes on Ceylon," (1862), page 156, says: "Sharks of the ordinary description are frequently seen; and on two occasions my attention has been called to spotted ones of such monstrous size as to make the common ones at their sides appear like pilot-fish."

The next describer of the Whale Shark is August Dumeril (1865), who, however, had only the skin of the Table Bay specimen and Smith's descriptions to work upon. He gives a very clear and comprehensive description, but adds nothing to our knowledge save in the matter of teeth, which will be considered later.

In 1865, Dr. Theodore Gill described from the Gulf of California a spotted Whale Shark which, misled by Smith's description and Müller and Henle's erroneous figure of the teeth, he differentiated from the genus *Rhineodon*, while retaining it in the family *Rhineodontidæ*, under the name *Micristodus punctatus*. His statement (omitting the description of the teeth to be given later) is as follows:

"In the year 1858, the Smithsonian Institution received from Capt. Stone the jaws and vertebræ of an enormous species of shark existing in the Gulf of California and known to the inhabitants of the neighboring regions as the 'Tiburon Ballenas,' or 'Whale Shark.' The specimen represented by the spoils was said to have been '20 feet long,' with a 'head, 6 feet wide,' 'pectorals, 3 feet long' and 'flukes, 6 feet between tips.' 'The back from the head to the first dorsal fin, brown, with reddish spots.' The head is represented as truncated in front.

"This type will be seen, therefore, to be very distinct, but is evidently related to the South African genus *Rhinodon*, and must be referred to the family of *Rhinodontidæ* with the name of *Micristodus punctatus*."

Jordan and Evermann (1896) copy Gill without being able to add anything to our knowledge, since, when they wrote, no other specimen had been taken on the west coast of North America and so far as the present writer knows, this statement holds good to the present time.

In 1902, Mr. B. A. Bean published in *Science* a note on the coming ashore at Ormond, Florida, of an 18-foot *Rhineodon*, and in this referred to Dr. Gill's *Micristodus*. A few weeks later, Dr. Gill, in the same journal, after comparing the teeth of the Floridan and Californian specimens, declared them to be at least congeneric. To this conclusion Günther (1884) had already come.

We now come to E. Perceval Wright, a naturalist whose opportunities for the study of the Whale Shark have been greater than those of all scientists from Smith in 1829 to the present writer in 1913, all added together, and who has in comparison made less use of them than anyone else. In justification of this severe criticism, let us see what opportunities he has had and what he has done with them. Writing from the Seychelles, a group of islands in the western Indian Ocean northeast of Madagascar, he says in 1870:

"It was between this island and the eastern coast of Mahe that I had the good fortune to meet with the 'Chagrin.' I had often heard stories of this monstrous fish; but at first I attached as little credit to them as I do to the stories told by Bishop Pontoppidan about the 'Kraken'; however, Mr. (Swinburne) Ward having measured one that somewhat exceeded 45 feet in length, I felt bound to believe this evidence, longing all the while to corroborate it by my own personal experience. This I was able to accomplish, and, thanks to Mr. Ward's exertions, and to the offer of a reward of twelve dollars for the first specimen successfully harpooned and brought to shore, I was enabled to take photographs of two specimens, male and female, of this remarkable shark, and to preserve all the more important portions of each for a more careful examination in Dublin. This shark, which is—the north whale excepted—the largest of living animals, would appear to have a very limited geographical distribution, and, contrary to the general habits of the true shark, it is not a carnivorous but a herbivorous fish. I have seen specimens that I believed to have exceeded fifty feet in length, and many trustworthy men, accustomed to calculate the length of the sperm whale (one of the most important stations for this cetacean is off Ile Denis, one of the Seychelles Group) have told me of specimens measuring upward of seventy feet in length; it is a quiet, harmless fish, with a mouth of immense width, furnished with small teeth; it now and then rubs itself against a large pirogue, and as a consequence upsetting it, but under such circumstances, it never attacks or molests the men, and while it reigns as a monster among sharks, is not, despite its size, as formidable as the common dog-fish."

In his *Catalogue of Fishes in the British Museum*, Volume VIII, (1870), Günther quotes all the preceding writers, especially Wright, who had presented part of a pair of jaws to the Museum, but adds no new data.

Much of Wright's data is repeated in a paper published in 1877, and in his book, *Animal Life*, published in 1879. Now it will be noticed that Wright says that these sharks were common at the Seychelles. He saw at least four of them, he photographed two, and dissected at least two, and sent parts to Dublin for further study; but he never published his photographs, and never described any of the external or internal structures of the fish. To make sure of these points, I addressed a letter to the Librarian of Trinity College, Dublin, asking about these preserved parts.

This letter was answered by Dr. Henry H. Dixon, Professor of Botany in Trinity College, who kindly writes that neither preserved material nor photographs of Wright's specimens are known at the College. Dr. Dixon notes that Wright apparently made a report at the 1869 meeting of the British Association under the title, "*Rhinodon typicus*, the largest known shark," but that this was never published. Further than this, neither he nor Mr. Alfred de Burgh, assistant librarian, working from the published bibliography of Wright's papers, have been able to find any further published data. It is a great loss to science that Wright appar-

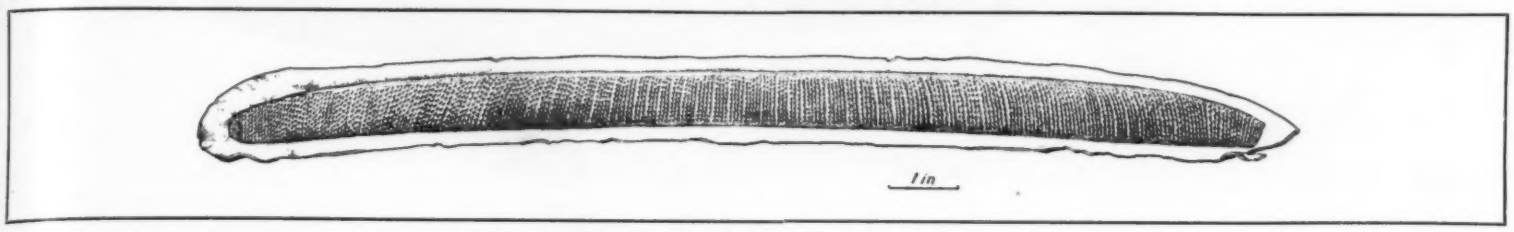


Fig. 12.—Dental plate of upper jaw of Ormond, Florida, specimen.
After Bean (1905).

Fig. 10.—Teeth of Rhineodon typicus.
As represented by Muller and Henle. After Bean (1905).

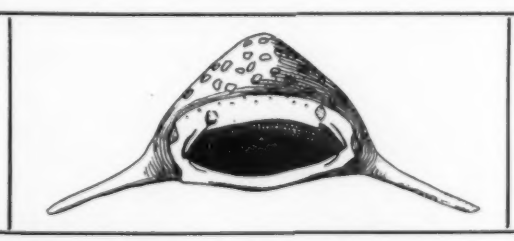


Fig. 8.—Frontal view of R. Pentalineatus (Fig. 2).
After Kishinouye (1901).

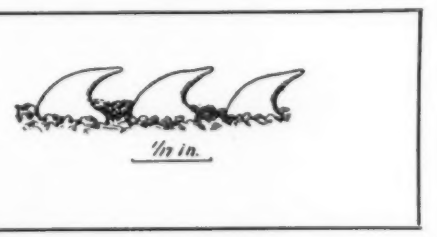


Fig. 13.—Teeth of Ormond, Florida, specimen
After Bean (1905).

[1] Dr. Buist's information came from a correspondent at Kurrachee.

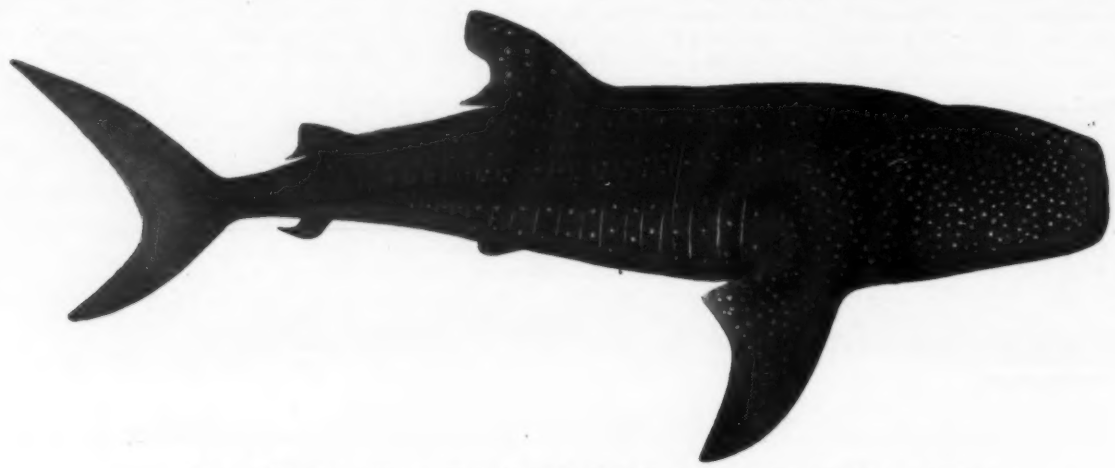


Fig. 1—Rhineodon typicus. Plate 26 of Smith's illustrations of South African Zoology.
From Bean (1905).

ently made so little of his extraordinary opportunities.

In his "Introduction to the Study of Fishes" (1880), Günther gives a very general description of the Whale Shark, based evidently on Smith's and Wright's papers. There is nothing in it to detain us, since the new bit of data refers to its food and will be considered later."

In the *Annals and Magazine of Natural History* for 1883, A. Haly, director of the Colombo Museum, records the capture of a *R. Typus* near Colombo, Ceylon, in 1883. This was a female, 23 feet 9 inches long, and 13 feet in circumference, having a mouth 3 feet wide. removed, it was handled only with the greatest difficulty. It was too large to be taken into the museum after mounting, so it was necessary to convert the main hall of the museum into a taxidermist's room.

The next reported capture of the Whale Shark is in 1884 by Signor G. Chierchia, whose interesting account is quoted *in extenso* from *Nature*.

"While fishing for a big shark in the Gulf of Panama during the stay of our ship in Taboga Island, one day in February (1883), in a dead calm, we saw several great sharks some miles from our anchorage. In a short time One of the boats was filled with water. At last the animal was tired by the great loss of blood and the boats assembled to pull in the line and tow the shark on shore.

"With much difficulty, the nine boats towed the animal alongside the Vettor Pisani to have him hoisted on board, but it was impossible on account of his colossal dimensions, but, as it was high water, we went to a sand beach with the animal and we had him safely stranded at night.

"With much care were inspected the mouth, the nostrils, the ears and all the body, but no parasite was

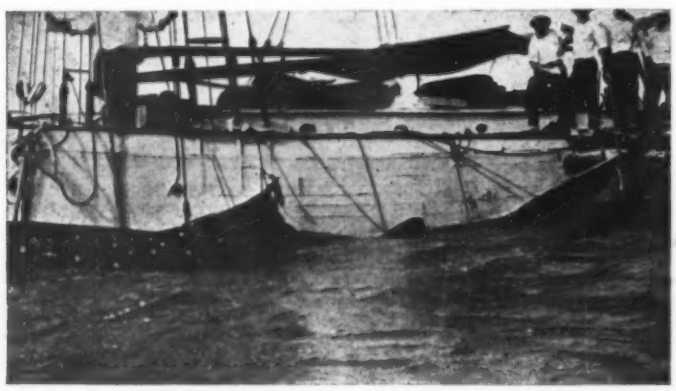


Fig. 4.—Rhineodon typus. Miami, Florida.
Showing dorsal fins together with spots and vertical bars.

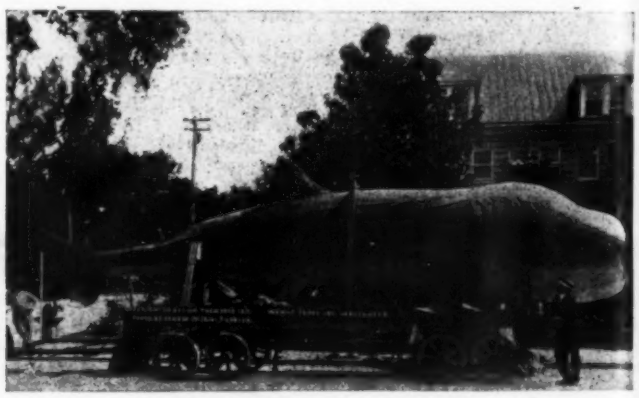


Fig. 6.—Miami specimen after mounting
After Townsend (1913).

Before drying had taken place, the lower jaw was flat underneath, grading without break into the abdomen, and projecting so far beyond the upper that its band of teeth was uncovered. Haly dissected this specimen hoping to find eggs or embryos but found her barren. Unfortunately he gives no description of the reproductive organs.

In the following year, Haly (1884) in his report for 1883 as director of the museum, says that this fish was taken at Moratuwa on January 5th, 1883, and that its weight was so great that even after the viscera had been several boats with natives went to sea, accompanied by two of the Vettor Pisani's boats.

"Having wounded one of these animals in the lateral part of the belly, we held him with lines fixed to the spears; he then began to describe a very narrow curve, and irritated by the cries of the people that were in the boat ran off with moderate velocity. To the first boat which held the lines just mentioned, other boats were fastened, and it was a rather strange emotion to feel ourselves towed by the monster for more than three hours with a velocity that proved to be two miles per hour. found. The eyes were taken out and prepared for histological study. The set of teeth was all covered by a membrane that surrounded internally the lips; the teeth are very little and almost in a rudimental state. The mouth, instead of opening in the inferior part of the head as in common sharks, was at the extremity of the head, the jaws having the same bend.

"Cutting the animal on one side of the backbone, we met (1) a compact layer of white fat, 20 centimeters deep; (2) the cartilaginous ribs covered with blood vessels; (3) a stratum of flabby, stringy, white muscle,

Fig. 11.—Photograph of vertical row of teeth.
From dental plate of *Micristodus punctatus, Gill.* (Twelve times enlarged.) After Bean (1905.)

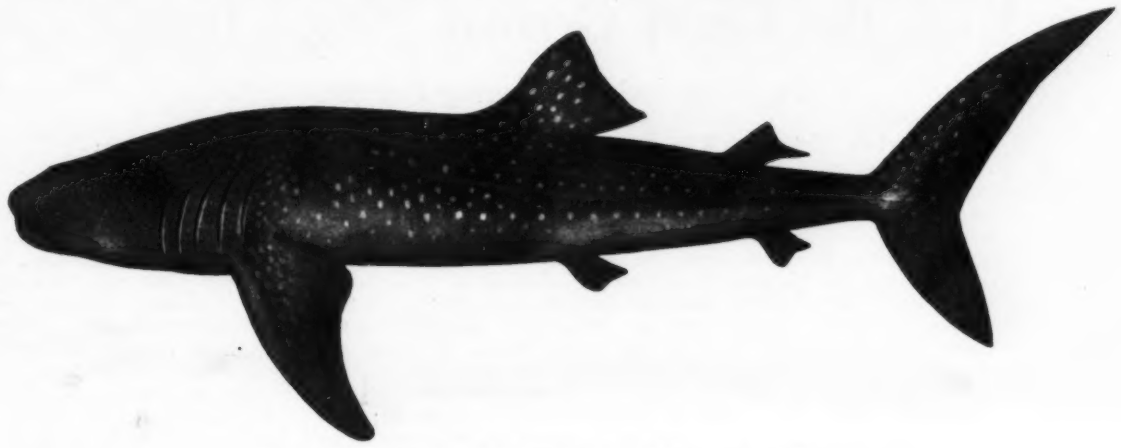


Fig. 9.—Wash drawing of Rhineodon stranded on coast of Florida.
Made from the skin and photographs by Mr. A. H. Baldwin. After Bean (1905)

60 centimeters high, apparently in adipose degeneracy; (4) the stomach.

"By each side of the backbone, he had three chamferings or flutings, that were distinguished by inflected interstices. The color of the back was brown with yellow spots that became close and small toward the head, so as to be like marble spots. The length of the shark was 8.90 meters from the mouth to the pinna caudalis extremity, the greatest circumference 6.50 meters, and 2.50 meters the main diameter (the outline of the two projections is made for giving other dimensions).

"The natives call the species tintoreva, and the most aged of the village had only once before fished such an animal but smaller. While the animal was on board, we saw several *Remora* about a foot long drop from his mouth; it was proved that these fish lived fixed to the palate, and one of them was pulled off and kept in the zoological collection of the ship."

This description was sent by Chierchia to Günther who, in the same number of *Nature*, commented most interestingly on *Rhineodon*. In addition to the occurrences hitherto noted Günther says that in 1878, Prof. W. Nation examined a specimen taken at Callao, Peru, and sent a portion of the dental plate to the British museum. Being unable to run down this reference, I referred it to my friend, Mr. H. M. Lydenberg, Reference Librarian of the New York Public Library, who kindly informs me that Nation had his headquarters at Lima, and that he was a corresponding member of the Zoological Society of London. However, in none of the publications of the Society about this time, nor in the Royal Society Catalogue is there reference to any paper on *Rhineodon* by Nation.[4]

In *Elements of Zoology*, by C. F. and J. B. Holder (1884) there is a very crude figure of the Spotted Whale Shark. In fact, it is mottled rather than spotted, is devoid of keels and cross-bars, and in general is so imperfect that it does not seem necessary to reproduce it here.[5] In the following year (1885) Dr. C. F. Holder published his interesting book, *Marvels of Animal Life*, in which he gives some data concerning our fish, mainly taken from Wright but in part descriptive of the Ceylon specimen—the latter data communicated to him by Col. Nicolas Pike, who had visited Ceylon the previous year. The figure in his book is, like the preceding, more

Fig. 2.—Rhineodon typus. Miami, Florida.
Showing size of mouth. After Townsend (1913).

or less the product of the fancy of the artist and calls for no reproduction.[6]

In his report of the Colombo Museum for 1889, Haly (1890) notes the capture at Negombo, Ceylon, earlier in that year, of an 18-foot specimen. The skin of this specimen was presented to the British Museum where it was mounted and is now on exhibition. It is presumably the skin elsewere referred to as mounted by Gerrard.

In 1894, Edgar Thurston, of the Madras Government Museum, published the following interesting account of specimens from Ceylon and the east coast of India.

"While in Colombo, I took the opportunity of examining the excellently preserved specimen of *Rhineodon typicus* in the Ceylon Government Museum for the sake of comparison with the specimen, 22 feet in length from the end of the snout to the extremity of the tail, which was cast on shore at Madras in February, 1889, when I was unfortunately far away from headquarters, so that the chance was missed of examining its stomach contents and internal anatomy. The telegram which reached me, announcing the arrival of the monster ran as follows: 'Whale on shore. Stupendous spectacle.' But, on the following day, I learnt, from the evidence of an expert, that the whale was a shark. As the following extract shows, but few specimens of this gigantic elasmobranch have been recorded."

The "extract" referred to gives a resumé of the work of Smith, Wright and Haly, and notes that the latter succeeded in obtaining several specimens. One of these was the 1889 specimen which was presented to the British Museum. This, it is stated, has been mounted by Gerrard, and though only a small specimen 17 feet long, makes a striking object in this great museum. In a foot-note, we read that in April, 1890, another small specimen 14½ feet long was taken off Bambalapitiya, Ceylon.

Who the author of the above "extract" is, I have been unable to ascertain.

In his *New Natural History*, Vol. V (1901), Richard Lyddeker, under the heading "Basking Shark, *Rhineodon typicus*," gives some general data, and his figure on page 2903 is only a fair adaptation of Smith's figure (1849).

(*To be continued.*)

GERMANY has abundant supplies of potatoes, beet-roots and turnips, materials holding carbohydrates. Albuminous fodder, however, was scarce and had to be largely imported. An invention recently made in Berlin, says the *Scientific American*, provides a nourishing yeast containing more than 50 per cent of albumen, prepared from sugar and ammonium sulphate. The sugar is bound to an inorganic base; in order to supply the albumen, the sugar is "fertilized" with ammonia, potash and magnesia, in the form of their salts, after which some yeast is introduced and a strong air current applied. The yeast then absorbs the sugar and the "fertilizer," thus resulting in the formation of a highly albuminous yeast.

[4] Since writing the above, I have accidentally found (January 2nd, 1915) that Nation published his account in the *South Pacific Times* issued at Callao on January 24th, 1878. This journal is not to be found in either the Library of Congress, the New York Public Library, or the Library of the British Museum, and as there is not time to get a transcript from Callao, it is impossible to give Nation's description here.

[5] By an interesting coincidence, while reading the third proof of this article, the original drawing of this figure has been received. For it, I am indebted to the kindness of Dr. C. H. Townsend, who found it in the library of the New York Aquarium. The published reproduction in Holder's book is the first figure I ever saw of the Whale Shark.

[6] In a personal letter to the present writer, Dr. Holder says that these figures are the work of artists employed by the publishers and for which he is in no wise responsible.

Fig. 5.—The whale shark on the marine railway at Miami.
To show mouth, teeth, nasal flaps, spiracle and gill-slits.

Fig. 3.—Rhineodon typus. Miami, Florida.
Showing great size and length.

Kiel, the Great German Naval Base*

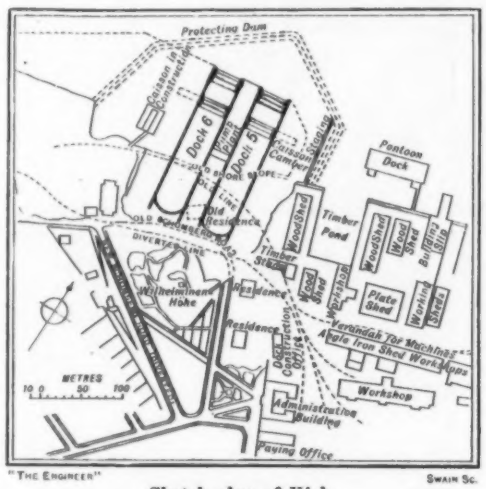
Its Naval and Engineering Features

By A. Wharton Metcalfe, B.Sc., Past President Bristol Association of Engineers

APART from the canal, Kiel itself possessed prior to August 4th, 1914, engineering features likely to be of special interest; among these the pneumatic methods and means adopted there in drydock construction are the most remarkable. Though not precisely novel, the scale upon which they have been used at Kiel constitutes the work a technical precedent while marking an epoch and a new departure in the practice of marine civil engineering. Since the date named other features, latent naval ones, have asserted their actual importance and vie with the former in interest.

Kiel, on the Baltic fjord of that name, was ceded to Prussia in 1864 after the second Danish war, and at once superseded Danzig as her naval base. Bismarck provoked the war partly with a view of obtaining a northern terminus for a contemplated Baltic-Elbe strategic canal in Holstein territory. This canal was eventually constructed and opened in 1895 by William II and named after him. It had originally a top width of 67 meters, now 102 meters; bottom width 22 meters, now 44 meters; and a depth of 9 meters, now 11 meters.[1] It was deepened after the advent of the Dreadnought, in 1905, upset Germany's naval plans, and so incidentally, probably, deferred the present Armageddon by a few years. The acquisition of Kiel strengthened Prussia's maritime position, an advantage that consequently accrued to the German Empire on its establishment in 1871. German naval aspirations on the later large scale realized between 1898 and 1914, so far as the erection of a great Imperial navy affected them, must be dated back to the cession of Kiel. The center of gravity of German naval *war* strategy has oscillated between the Baltic and the North Sea and is now established at Wilhelmshaven, while Kiel adapted to construction comes next in importance. The canal effects a saving between these two naval bases of about 540 miles in distance, which the dangerous coastal circumnavigation of Denmark would otherwise involve. It must not be forgotten that Danzig, once Prussia's naval headquarters, is still a minor naval port of the German Empire and is very strongly fortified; similarly it must be remembered that Kiel is fortified, so also Holtenau, the northern end of the canal; Brunsbüttel, the southern, and Wilhelmshaven and Helgoland, which protects the entrance to the Elbe, and that all approaches are mined. Therefore an offshore line commencing at Danzig and drawn through these places in succession, defines the continental or landward aspect of Germany's naval defense scheme; or, in other words, the line of resistance behind which the navy can screen itself, upon which it is based, and from the fortified naval stations on or behind which fleets or units can operate. Of this line sixty miles are canalized, and that portion is, as indicated before, a short cut between the principal naval stations on the Baltic and on the North Sea, which, moreover, saves what would otherwise imply an exposure of 600 miles to the risks incident to sea and war.

The canal, only open to aerial attack, possesses the additional advantage of enabling Kiel to support Wilhelmshaven or *vice versa* and of enabling naval forces to be rapidly concentrated in the Baltic or North Sea as circumstances require, always assuming—as has happened in the present war—an alert enemy does not bottle up the fleet. The Kiel Canal, the vital artery between the principal naval bases of the empire, is essential to a German naval defense scheme, and manifestly fulfills the wish of Bismarck for a strategic canal more especially in its naval ascept. If Treitschke and Nietzsche share the responsibility of preaching the gospel of force, that might is right, the Iron Chancellor never failed to practice it. It was with visions of the Hanseatic League in his mind that Treitschke was wont to assert that Germany was once the first maritime power of Europe, and he hoped might be so again. His followers probably see in present events what they hope may be a phase of history in the repetition. On this head it is sufficient to say that, while there exist grounds for a German naval tradition, her efforts to exercise naval power lack historic continuity, having been frequently interrupted and for long periods; moreover, the exercise of sea power since the end of the sixteenth century differs essentially from the armed efforts afloat of the Hanseatic era; as anyone will concede who understands the meaning of the term sea power as developed, expounded, and established by Mahan. In the light of the teachings of the theory and practice of the subject as illustrated in his "Influence of Sea Power Upon History" it is abundantly clear that any attempt to compare the maritime operations of the two periods, though it may prove interesting and diverting, will yield few results of any value. The naval aspirations of Prussia which commenced with the acquisition of Kiel, were galvanized into life after the establishment of the German Empire and confederation under the hegemony of Prussia in 1871, when, consequent upon the Franco-German war, an industrial expansion took place which so transformed Germany that she passed from an agricultural phase to one in which manufacturing, commercial, and maritime interests predominated.



Sketch plan of Kiel.

The facilities for naval construction, armaments, equipment and repair at Kiel comprise the works of the government, those of Messrs. Krupp, a branch of their greater works, and the Howaldt Works.

The Government Establishment.—This includes four building and patent slips, six drydocks—two modern and of large size, Nos. 5 and 6—of the following dimensions: Useful length, 574 feet; useful width, 98.40 feet; depth on sill at H.W.O.S.T., 36.90 feet. There is also at the new harbor at Wick Bay, south of the Holtenau mouth of the canal, an establishment for torpedo craft.

The Germaniawerft Yard.—This was acquired by Messrs. Krupp from their predecessors in 1902. The equipment of the yard allows of every kind of work appertaining to mercantile or naval marine construction of whatever size being undertaken, whether new construction, repair and outfit, or armaments and gun mounting is concerned. The works have a sea frontage of 870 yards and an area of 280,000 square yards, of which over 120,000 square yards are built over. The most modern plant, telephone, telegraph, and electric light and power plant is everywhere installed, and nearly five miles of standard gage and two and one half miles of narrow-gage railway facilitate transport throughout the yard. The official staff numbers 6,000 and the employees number 60,000, for whom workmen's colonies, recreation rooms, reading rooms, hospitals, and benevolent institutions have been provided by Messrs. Krupp; in fact, the Krupp establishments would furnish an object lesson in town planning to the Local Government Board or any local authority, metropolitan or provincial.

The Howaldt Works.—These works provide a floating dock capable of taking vessels of 11,000 tons. Further particulars the writer has been unable to obtain, and he regrets space precludes his dealing with the Germaniawerft establishment as fully as he wished.

The second feature of Kiel, associated with the construction of the Government Drydocks Nos. 5 and 6, now calls for attention. The limits imposed upon the writer permit only a brief general description of the most interesting features of the work, all details not essential to its comprehension being necessarily omitted, particulars of which would be given here were space available. They are obtainable in a very complete form in two articles communicated by the engineers, but are in German.[2]

The decision in favor of two drydocks over a floating dock affording the same accommodation was determined very largely by the desire to avoid the enormous amount of dredging and objections thereto incident, which the deeping of a channel that would permit the passage of a deeply immersed dock supporting a damaged and perhaps partly waterlogged battleship would involve.

Two parallel docks Nos. 5 and 6, Fig. 1, were therefore planned, situated on an area part of which is above and the rest below average sea level. Close proximity to the dockyard workshops was also an important factor in the choice of a site, as was also the desire to avoid all unnecessary or avoidable interference with existing works, buildings, public roads, and railways. Further, the site had to be considered with a view to probable future lengthening which the rapidly increasing length of ships might demand. The site shown satisfied all the conditions required; as regard the docks themselves, the contingency of lengthening was provided for by horizontal arched ends abutting against skewbacks in the side walls.

The difference of flood and ebb tide level at Kiel is hardly noticeable; yet, on account of the wind there is never any lengthy duration in the constancy of sea level, which is lowest after westerly winds and highest when an easterly wind suddenly follows upon a westerly one. The maximum recorded height above mean low-water level is 10 feet 6 inches, the maximum fall below 5 feet 2 inches, but variations of 3 feet 4 inches above and 1 foot 8 inches below are quite common. In the absence of wind mean tide level coincides with the zero of the tide gage, to which point all levels are referred to as Datum.

The body of the dock is mainly composed of trass concrete, trass being comminuted volcanic rock. The caisson abutments and dock ends are of granite, the altars of basaltic lava. The surfaces of the keel and bilge block ways are faced with granite. The side walls are covered with hard burnt tiles.

* *The Engineer.*

[1] See *Le Génie Civil*, August 15th, 1914; also *Jahrbuch der Schiffbautechnischen Gesellschaft*, 1913, where the widening of the canal and new locks are described.

[2] *Zeitschift fur Bauwesen*, 1903. See also two articles on "Pneumatic Methods in Engineering," by the writer, in the October and November numbers, *United Service Magazine*, 1910.

Micro-Organisms and the War

IN all wars of any magnitude, other than the one now in progress, the loss of life from disease has been considerably greater than that resulting from wounds. In the present war the bacterial foes are being so efficiently dealt with that the state of affairs is likely to be reversed, thanks to the great efforts that are being made to lessen both medical and surgical infection.

There are many causes operating to produce this result. Of course, general hygiene has been very carefully attended to, so that the sanitary conditions in camps and other places where men are gathered together for training are very much better than have ever been obtained before. At the same time, the method of vaccination, particularly against typhoid and tetanus, has been exceedingly efficient. In the case of typhoid, which has been the most prevalent of all epidemic diseases in previous campaigns, the result has been nothing less than extraordinary, and the method of anti-typhoid inoculation has proved a marvellous success.

One important factor—the water supply—has been dealt with very thoroughly, and it is not too much to say that at the present time arrangements are in force which, if only carried out thoroughly, as they should be, leave little room for any danger occurring either to the men under training, or to those actually on service at the front. As to the danger of wound infection, that is a very real one. Those fighting in France are under the influence of a soil that is highly manured, and which is as a result highly productive. Its very productivity shows that it is a good bacterial culture medium, and the result is that a wound, when it occurs, is at once exposed to a chance of bacterial infection against which it is extremely difficult to provide, although the men are supplied with first-aid appliances of the best description. As a result, it is a point for discussion whether an aseptic or antiseptic method of dealing with wounds is, under such conditions, the more efficient. There is much reason to expect that the methods of Lister and antiseptic methods in general will have to be re-introduced, and may prove, the soundest and most practical when dealing with infected wounds.—*Knowledge.*

The Medical Reserve Corps United States Army*

An Important Service That Has Been Neglected

Congress, by an act approved April 23rd, 1908, established a medical reserve corps and made it an integral part of the Army of the United States. This corps was organized "for the purpose of securing a reserve corps of medical officers available for military service." In accordance with the act many prominent civilian physicians in various parts of the country were nominated by the President and confirmed by the Senate as first lieutenants and the corps became an entity. Since that time hundreds of medical men have been commissioned and to-day the corps numbers about 1,400 officers.

Of these, according to the *Army Register* of 1914, 91 are on the active list. Over 60 received their appointments between 1908 and 1910 and are doing garrison and other duty, while most of the remainder are at the Army Medical School. Some of the men included in that number became first lieutenants in the Medical Corps in 1914, but the appointment of their successors makes the figures practically correct.

In other words, there are in the United States about 1,300 men holding a commission as first lieutenant in the United States Army and practising civil medicine. They are *bona-fide* Army officers, as their commissions confer upon them "all the authority, rights and privileges of commissioned officers of the like grade in the Medical Corps," and when on duty they receive the same pay and allowances.

Of what use are the officers on the inactive list to the army?

What are they doing for the Government?

What is the Government doing for them?

With great regret one must answer these questions as follows:

No. 1. At present practically none.

No. 2. Nothing.

No. 3. Absolutely nothing.

These answers will appear to the uninitiated as unbelievable, but they are true.

The inactive list of this great corps comprises one of the finest bodies of professional men in the world. On its roster are to be found some of the best known men in American medicine. Great surgeons, internists, therapeutists, sanitarians and leading representatives of all the specialties are on the list, but so lightly is their official connection regarded that their names are not even mentioned in the *Army Register*. The Navy is more thoughtful in this connection and its inactive reserve surgeons, headed by J. C. Da Costa and Hobart Amory Hare, are published as on "unassigned" duty.

Here we have, then, a large body of men, professionally among the leaders of the medical profession of the country, in the anomalous position of officers in an Army of which they are a part only so far as a piece of parchment signed by the President of the United States can make them.

Wherein lies the fault?

The only conceivable reason is that the Congress does not realize the potential value of the Medical Reserve Corps. It has created an organization for the specific purpose of securing trained medical officers whose services can be called upon in time of stress, but it forgot that most important feature—how to enable the men to become trained officers. The possession of a uniform and the right to wear it does not constitute a trained officer. That is the question of the inactive officers to-day. They can wear the different uniforms of the service if they care to purchase them. They can belong to those clubs and organizations to which only Army officers are eligible. They are entitled to the social position accorded Army officers if they practice near Army posts. These things and many more are theirs if they desire, but—and pay good heed—these advantages do not make them *trained* medical officers, as military medical men must be trained. Consequently, out of the approximate 1,300 inactive officers in the corps, it is safe to say that, aside from the small percentage of militia medical officers, 90 per cent of that great number are *absolutely ignorant* of all that constitutes the duty of a first lieutenant in the Medical Reserve Corps. They could not return the salute of a soldier, officiate at sick call, inspect kitchens or sinks, do "paper work" or any of the multitudinous duties that fall to the lot of a medical officer, because there is no counterpart for these duties in civil life. Professionally the inactive officer is the peer and often the superior of the regular officer, but military medicine is vastly different from civil practice and requires training along very different lines.

Of the 90 per cent of men ignorant of miliary amenities, usages and practices, a large percentage are anxious to perfect themselves in their shortcomings, but—the Congress has made no provision for their training, so they must perforce remain in ignorance. It is not the fault of the officers of the corps. They have begged to be given an opportunity to go to a camp of instruction, but the same old stereotyped answer is returned, "no appropriation."

Militia medical officers go to camp every year and to an armory once or twice a week. In consequence they are well trained and in time of war would do effective work in the field. Where would the Reserve Corps officer be if ordered to active duty and put in command of an evacuation hospital?

The members of the New York Division of the Association of the Medical Reserve Corps have been most active in their efforts to get an opportunity to fit themselves for military service. They have had the active co-operation and assistance of regular officers stationed in and around New York, who have given them interesting talks, but it is doubtful if five men in the division could successfully order the erection of an officer's tent or go through the litter drill. Indeed, very few have ever seen this work done.

The New York officers, upon their organization two years ago, were most enthusiastic, but as time went on and the indifference of the Congress to the corps became more apparent interest slackened. Attendance at meetings fell off, some resigned to accept commissions in the Navy, where service on ships was promised, and others resigned, as they saw nothing ahead. Some men became lukewarm, but kept the commission in the hope that some day they would have reason to value it for what it really means.

The only work given the men consisted in sending twelve to Gettysburg in 1913 to serve during the week of the veterans encampment. As far as it went, the experience was novel and the few attached to the field and regimental hospitals gained a little real insight in the work of the medical officer. In 1914 it seemed as if some men would be ordered to Tobyhanna, Pa., for instruction. Two majors of the Medical Corps were sent there as instructors, but the old bugbear—no appropriation—again loomed up, so that only a few officers took advantage of the occasion. Uncle Sam can hardly expect physicians to leave lucrative practices and pay all their traveling and living expenses while studying to better serve their country. There is a limit to the patience, even of a medical reserve officer, who is fighting hard to perfect himself, so that he can serve a government that would seem to be fighting just as hard not to allow him to so do.

This fight is an unselfish one. Unlike many positions under governmental control, there are no "pickings." The high character of the inactive officer dissipates any suggestion that financial consideration plays any part. Active service would mean tremendous loss to the great majority of the corps, as many of the city practitioners pay as much for office rent as they would receive in a year's salary as first lieutenants. These men are actuated solely by the highest patriotic motives. Possibly the feeling is best expressed by quoting from the address of Dr. Henry C. Coe of New York, the most active first lieutenant on the inactive list, to the graduating class of the Army Medical School last June.

"We are," he said, "soldier and citizen alike, essentially men of peace, but deep within us smoulders that hidden fire of patriotism, civic as well as military, ready to leap into flame when there is wrong to be redressed and the honor of the flag to be upheld.

"I beseech you, do not envy us our fine houses and our worldly success. Yours is the better part. You will never know the fierce competition of modern life, in which the weaker is thrust to the wall; the petty desire for notoriety, the ignoble straining after money and social distinction. In your little circle your faults, your virtues, your present attainments and future possibilities are all recognized and you are accepted at your 'face value.'

"'To be content with small means,' as Stevenson puts it, to realize that 'it is better to toil hopefully than to arrive'—is not this the true philosophy of life? I wish that I could make you feel how much sweeter and manlier and more helpful you can make your lives, how much more of a benediction to others than can we who are handicapped by our artificial environment. The virtues of self-control, of prompt obedience, of nice regard for the rights of others, especially your inferiors; the strain of city life, the rush of business, the keen professional competition too often destroy these virtues in us, if we ever had them. To escape from these sordid cares, to breathe the free air of the camp, to renew the sacred traditions that cluster around the flag, to be under canvas again with real men—this, to me, is like inhaling the ozone of the mountain top after breathing the fetid atmosphere of the marshes."

Can the Congress afford to ignore the spirit that actuated the writer of those stirring words?

Will the Congress pay heed or will it pursue the course of watchful waiting, which has been so consistently carried out since 1908?

Potentially the Medical Reserve Corps is a splendid organization. As at present constituted it is valueless to the country and membership in it is valueless to the individual.

Its members are striving for the light of knowledge, which has ever been denied them. If such a course is pursued the corps will fall into innocuous desuetude and its value entirely lost. It will be discredited and good physicians will decline to again associate themselves therewith.

No problem of national defense can be considered complete until the Army surgeon has been provided for.

* *The Medical Times.*

Rare Gases in Natural Gas

The principal inert dilutant of natural gas is nitrogen, the proportion of which varies from 1 per cent or less to 30 or 40 per cent in gases used commercially and in exceptional cases much higher. A sample of marsh gas obtained from the State of Washington contained, according to analyses, as much as 98.5 per cent of nitrogen. This sample was taken from a small outburst of gas going to waste.

In ordinary gas analyses the nitrogen content is determined by difference, no attempt being made to isolate the so-called rare gases such as are associated with nitrogen in atmospheric air. The presence of these rare gases in natural gas is at present principally of academic interest, as they are inert like nitrogen. That they are present, however, in small proportions has been shown by several investigators. Cady and McFarland[1] determined that helium was present in forty-one samples, obtained from Kansas and other States, in quantities varying from a trace up to 1.84 per cent. The helium tended to increase with nitrogen but showed no direct relation.

Czako[2] also found small quantities of helium in six samples of natural gas he investigated, in proportions ranging from 0.0010 per cent to 0.41 per cent. Other investigators have found the inactive rare gases in earth gases, in connection with work on radioactive emanations. Helium especially has been the subject of considerable research, as it is regarded as the final product of all radioactive decomposition processes.

Numerous investigations begun about ten years ago showed that the majority of gas outbursts from the earth carry with them a radioactive emanation, which they have absorbed while passing through the earth strata within which the radioactive process of decomposition takes place. In many cases the emanation proved to be radium. Numerous minerals, rocks, soils, underground air and atmospheric air, as well as water and gases from springs, have been examined for their radioactivity, often in connection with their helium content.—*Technical Paper 109, Bureau of Mines.*

[1] Cady, H. P., and McFarland, D F., The occurrence of helium in natural gas and the composition of natural gas: *Jour. Am. Chem. Soc.*, vol. 29, 1907, p. 1523.

[2] Czako, Emerich, Contribution to the knowledge of natural-gas outbursts. Dissertation. Technical High School. Karlsruhe. 1913. 85 pp.

Mosques and other buildings are now erected in reinforced concrete in Egypt and other countries, and adhering to the national types of architecture as regards the design of such structures. Among others we mention the Sultan Hassan Mosque at Cairo, in which reinforced concrete enters largely. Another very handsome structure of Oriental type was recently erected near this city, the Grand Palace Hotel of Heliopolis. It is a vast building of four stories, and presents a pleasing aspect, owing to the excellent architectural design inspired by the prevailing styles. All these examples use the French Hennebique concrete system.

Signaling on Railway Trains in Motion—II

Various Sytems of Engine Cab Systems Used in France

Concluded from SCIENTIFIC AMERICAN SUPPLEMENT No. 2074, Page 221, October 2, 1915

Modifications Made After Experimental Trials.

(1) *Apparatus Fixed on the Track. Cells.*—The two batteries installed at the signal post have been replaced by a single battery, each pole of which is connected alternately to the "ramp" and the earth.

"Crocodiles" or Ramps.—The ramps described have been replaced by a ramp in the shape of a gridiron, and

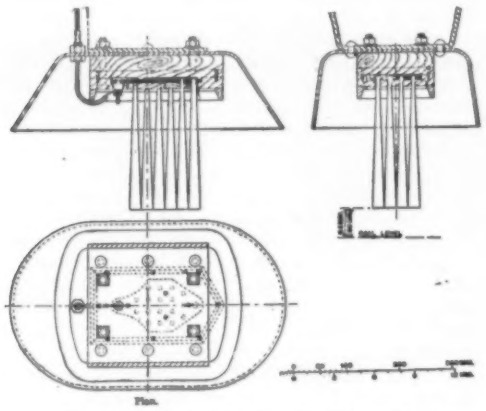


Fig. 14.—Brush collectors fixed to engine.

composed of bars or anglebars parallel to the track. The object of this modification is to eliminate the causes of failure due to hoar-frost. Experiments have been carried out on a ramp, the surface of which was protected against hoar-frost by petroleum oil dropping over it continuously.

(2) *Apparatus Fixed on the Engine. Brush Collector.*—The modification to the brush follows that of the "ramp." Instead of a collector consisting of copper wires, a very rigid brush is used, Fig. 14, made of steel blades with a section 1 millimeter by 3 millimeters (0.04 inch by 0.12 inch). These blades are made up in bundles of four. Their passage between the bars of the ramp scrapes off the hoar-frost and a good electric contact is insured under all conditions.

Warning Apparatus.—In future the releasing of the armature at the registering apparatus (signal being at "danger") will be used to work the warning apparatus. This releasing force will be increased by means of compressed air, or by gearing on the main shaft of the speed indicator. In the first case a balanced valve will operate the air whistle placed in the driver's cab; in the second case, the admission of steam will be done mechanically. Thus the Servo motor and corresponding electric circuit will be dispensed with.

Testing the Working of the Apparatus.—For this purpose the releasing of the armature at the registering apparatus is used (signal being at "safe"). This sets a bell ringing when the engine passes a signal at "safe." The driver thus knows if his apparatus is in working order.

SOUTHERN RAILWAY.

A. Herdner, locomotive and rolling stock superintendent, sent a copy of service instructions, describing the warning and registering apparatus for danger signals, adopted by the Chemin de fer du Midi. He also sent a drawing showing the general installation of the apparatus on one of the express engines, together with a diagram of the installation on the track. The warning and registering apparatus, which is now being experimented on twenty engines and thirty automatic signals, differs from the one mentioned above, in that the battery is placed on the engine instead of on the track. Moreover the original apparatus does not possess an appliance by which the driver's vigilance may be controlled.

Description of the Installation.

Apparatus Mounted on the Engine.—This consists of:

1. A metallic brush collector fixed on an insulated support under the rear platform of the engine, Fig. 15.

2. A special steam whistle controlled by a Servo-motor, Fig. 16. The latter receives steam from the boiler through a pipe branching off the pipe through which steam is supplied to the whistle, and which is normally closed by a valve controlled by an electro-automatic contrivance to be described hereafter. The steam pipe of the special whistle is provided with a stop-cock at the boiler end, so that, in case of necessity, the warning apparatus may be cut off.

3. An electro-automatic contrivance by Lartigue and Forest, fixed on the screen of the cab, and working on a shaft, two special stylo pens of the Hausshaelter speed indicator, as well as the valve admitting steam to the Servo-motor of the warning whistle. The shaft of this apparatus carries a hand lever within reach of the driver.

4. An insulated conductor connecting the brush to the electro-automatic apparatus, which is itself earthed through the body of the engine and the rails.

5. An appliance controlled by a hand lever within reach of the driver, and working one of the special pens of the speed indicator.

Appliances Mounted on the Track.—This comprises for each disk:

1. An electric battery.

2. A fixed ramp which is installed on the track, parallel to the rails near the disk, in the line of action of the brush, insulated from earth, and connected by an insulated wire to one of the poles of the battery, Fig. 17.

3. A switch disposed so as to establish the connection between the second pole of the battery and the rails when the disk is turned to "danger."

The Operation of the Apparatus.—The moment the driver of a train sights a disk turned to "danger" he must immediately work the handle of the control apparatus, which then causes the special pen to trace a particular mark on the paper of the speed indicator.

When the engine arrives at the stop signal, the collector rubs on the ramp, and the circuit is closed, on one side through the switch of the disk, and on the

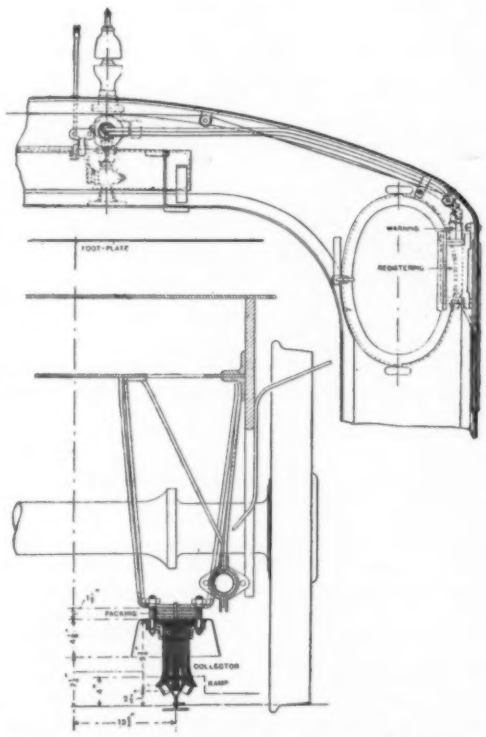


Fig. 15.—Electro-automatic warning and registering apparatus fixed to side of cab.

other through the brush in contact with the ramp. The current then passes through the electro-automatic apparatus and releases it, so that its shaft works simultaneously the two special pens of the Hausshaelter indicator and the steam valve of the Servo-motor. The two pens trace on the same vertical on the paper of the speed indicator two special marks, which must follow the single mark made by the controlling device; the valve, admitting steam to the Servo-motor, sets the warning whistle going.

The driver stops this by pressing on the lever of the shaft, thereby closing the valve and bringing back the armature of the magnet, and thus closes the steam valve.

Instructions to be Observed in the Working of the Warning and Recording Apparatus for Stop-Signals.

Article 1. The use of the warning apparatus for stop-signals in no way modifies the directions which the drivers must follow in the presence of "danger" signals and of extinguished or doubtful signals.

Article 2. Any automatic home-signal which is set so as to cause the warning-signal apparatus and the recorder to act must be considered as at "danger," whatever may be the position of its flag or of its vane.

Article 3. Drivers must report in their journal all incidents referring to the working of the warning and recording apparatus (normal working, non-working in the presence of a disk provided with the special appliances, working at the wrong time, etc.).

Article 4. The officials at the sheds, who couple the engines fitted with the warning and recording apparatus, will report in the ordinary way any breach of orders and regulations which an examination may disclose.

They will ask the drivers who have not operated the apparatus of control in due time to give explanation.

They will, besides, prepare at the beginning of each month for the preceding month, a report of all the incidents relating to the working of the electro-automatic apparatus mounted on the engines belonging to their sheds.

These reports will be addressed to the District Engineer, who will forward them on the 15th of each month to the Locomotive Superintendent.

STATE RAILWAYS.

Mr. A. Claveille, general manager of the State Railways, states that four safety devices are being subjected to comparative tests on the Chemins de fer de l'Etat. These are:

(*a*) The 'Cousin" system fixed to 55 locomotives.
(*b*) The "Van Braan" system fixed to 28 locomotives.
(*c*) The "Augereau" system fixed to 2 locomotives.
(*d*) The "Est" type-apparatus fixed to 27 locomotives.

These different systems are still in the experimental period.

The following descriptions are taken from a printed book describing the Cousin system and from drawings which have been sent to the Institution.

The Warning Apparatus.—A tube *A*, Fig. 18, is supported by two brackets bolted on the frame of the engine, and is fixed in them by two pins.

A steel rod *B* moves freely in the tube *A* longitudinally, in the direction of the arrow (as shown), its total displacement in that direction being $x = 9$ millimeters (0.35 inch). Two pins *aa* pass through the rod, through the tube *A* and through two rings *bb*, to the outside of which they are riveted. The longitudinal motion of these pins is provided for by two slots cut in the tube *A*. At its left extremity the rod *B* screws on to a buffer, which butts against the piece carrying the electrical connection for the recording apparatus. A spring brings *B* back into position, i. e., from right to left. On the tube *A* are four sleeves, two sleeves *c* and *d* to the left and two to the right. These sleeves are cut at one end (Fig. 19) so as to unlock in only one direction of rotation. This is, for the pair of sleeves to the left, the reverse of what it is to the right, as indicated by the arrows, Fig. 18.

Cast on each sleeve are two keys, one on each side. These slide in grooves inside the sockets *C* and *D*, and compel the sleeves *cd* to turn with the latter. The sockets carry hanging arms *EF*. At the top they are coupled to four strong springs fixed inside the cylinders *ef* these springs tending to bring them back into position the moment they are displaced.

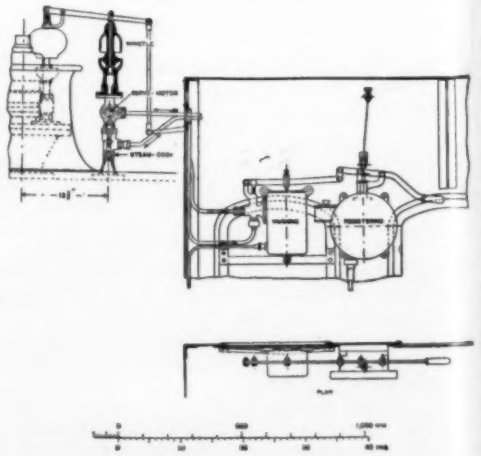


Fig. 16.—Electro-automatic warning and registering apparatus, longitudinal section.

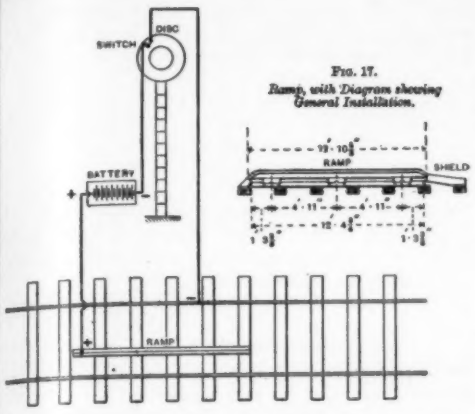


FIG. 17.
Ramp, with Diagram showing General Installation.

The hanging arms *EE* are the ones which come into contact with the ramp and are set at an angle when they pass over it, being immediately brought back into position by their springs when they are clear of the ramp. As will be seen, these arms are the ones which effect a longitudinal displacement of the rod *B*. They are called the "active" arms. The other two arms *FF*, called the "neutralizing arms" hang clear of the ramp, their only use being that, together with *EE*, they constitute a guard. If the obstacle be a small one it will have practically no effect on the arms on account of their strong springs holding them back. If it be a heavy one it will still produce no impression if only *F* butts against it. But if *E* catches it as well it might set the horn going. This will give the same result as if the engine had passed a danger signal—an accident which will be determined when the record chart is examined. Such an accident is termed "unlocking out of season."

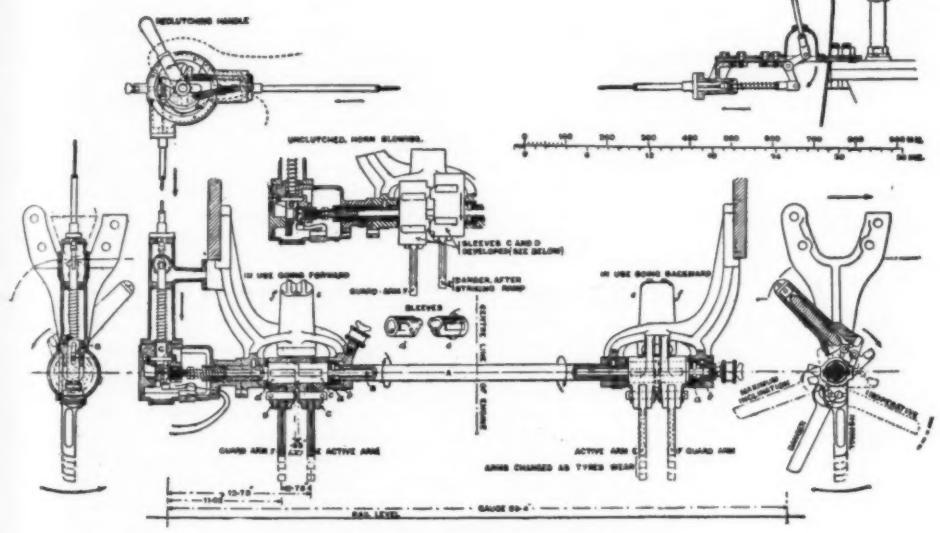


Fig. 18.—Warning apparatus, Cousin system.

The apparatus works in this way: When the arm *E* comes into contact with a ramp, it is moved at an angle, and turns the socket *C* partially round. This twist is taken up by the sleeve *c*, which unlocks away from *d*. As the latter is kept from sliding, *c* has to travel longitudinally. In so doing, it carries with it the ring *b* and thereby the rod *B*. Again, the buffer screwed to *B* moves back with the latter. The top edge of this buffer bears in a recess cut in the piston *G*. As soon as the buffer moves back, the piston is brought down sharply by its spring until it bears on the bolt which goes through it.

It is this sharp impact of the piston which unlocks the apparatus at the horn and sets it blowing.

Relocking takes place thus: The arm *E* goes back into position the moment it is clear of the ramp and the two sleeves *c* and *d* clutch again, but the buffer of the rod *B* is still bearing against the piston and the driver has to turn the hand lever to pull the piston up.

The electrical connection is simply used for the recording apparatus, which is the same in the main as described for the Eastern Railway.

The Crocodile or Ramp.—A, Fig. 19, is an angle-iron of fixed length and profile, pivoted at *B* on a bearing *C* which is bolted to the channel-iron *D*. *E* is a counterweight regulated so that *A* balances very sensitively, and just bears on the cam *G* with its pin *F*. This cam is keyed on the same shaft as the two sectors *HJ* which are weighted, and is regulated so that it sets the crocodile in position long before the danger signal is fully on. A chain, the end of which is pinned to *H*, establishes the connection with the signal. Inside the channel iron is a switch which works on and off according to the positions of *A* and rings a bell in the signal box.

PARIS, LYONS, AND MEDITERRANEAN RAILWAY.

Mr. L. Maréchal, Locomotive and Rolling Stock Superintendent, wrote that he could not for the present make any definite statement regarding warning and signal-recording apparatus on the line, as these had but recently been fixed on a few engines running on certain sections and were being experimented upon.

Mr. Maréchal referred besides to the difficulties inherent to the winter season, and suggested that it would be premature at this stage to say how efficient the apparatus was likely to be. This made him desirous not to make any statement before a long trial had taken place. But he would add that experiments were being carried out on 140 express locomotives and on 415 kilometers (258 miles) of double track with 316 disks fully equipped.

Though it was not possible to describe the apparatus, owing to the continual improvements carried out and the constant changes, yet he was willing to give the general principle on which it worked.

The warning and recording apparatus for signals at "danger," which is now being experimented upon on the Paris, Lyons, and Mediterranean Railway works thus when the engine goes over a ramp:

1. It actuates a special whistle which warns the driver and the stoker.

2. It traces on the roll of the speed indicator a conventional sign, the position of which notes the signal which was at danger. Both these results are obtained simultaneously by means of an assemblage of devices placed on the track and on the engine.

The apparatus placed on the track comprises an insulated conductor, called a "crocodile" or ramp, fixed between the rails near the signal corresponding to it, and a switch worked by the same signal and connected to the ramp and the rails.

The apparatus of the engine consists of:

A brush which rubs on the ramp when the engine passes over it.

A pneumatic horn giving the warning.

An automatic device for unlocking and sending compressed air through the horn.

An automatic device acting on the registering mechanism of the speed indicator.

An electro-pneumatic relay which provides the unlocking device at the horn and the registering apparatus with the compressed air required.

A battery which provides the electro-pneumatic relay with the current required.

A compressed-air receiver which feeds the apparatus. (On engines already provided with pneumatic brakes no extra receiver is necessary, the one used for the brakes serving both purposes.)

This warning and registering system is based on the combined use of electricity and compressed air. It makes it necessary to use switches and ramps similar to those adopted on other railways where the system is entirely electrical. In this latter case, electricity is the medium which brings about the unlocking of the apparatus during the very short time that the engine takes to pass over a ramp. This unlocking means a certain force being exercised, which, however weak, is *not* a negligible quantity, so that at very high speeds there might easily be failures.

In the Paris, Lyons, and Mediterranean systems, electricity comes into play, only to release the armature of the electromagnet of the relay and close a circuit itself, without doing any mechanical work. Through this local circuit of the electro-pneumatic relay (which is fed electrically from the battery on the engine and pneumatically from the receiver) being closed, the compressed air becomes the agent which provides the positive mechanical power required for unlocking and relocking.

ORLEANS RAILWAY.

(*Chemins de fer de Paris à Orléans.*)

Audible Signals Intended to Repeat Signals Along the Line.

E. Solacroup, Locomotive and Rolling Stock Superintendent, reports that for more than fifty years the Orléans Railway has used a signaling system consisting of signals placed at a distance in advance of the danger point, the unlocking of which, when set at "danger," is revealed by the explosion of two cartridges placed automatically on the track when the signal is at "danger."

These signals, which are placed at a great distance from the point they protect, are the order for "stop dead" when set at "danger." To steam past them brings a heavy punishment on the drivers, who therefore keep a vigilant look-out; and it is very seldom that they pass the posts, at any rate, not for a long distance.

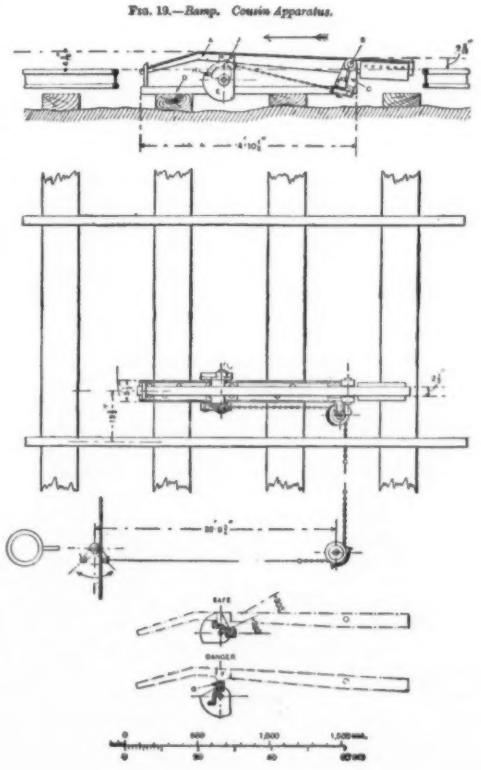
If, on account of atmospheric conditions or a moment's inattention, a driver does not notice the stop-signal, he will be warned of its presence at the moment he passes the post by the explosion of the two cartridges, which the signal has guided on the rails when turned on to "danger."

The distance between the point which is to be protected and the signal post is such that, even if the driver, due to circumstances as just mentioned, does not take measures to stop his train until after he has heard the explosion of the cartridges, he has still ample time to pull up before he reaches the obstacle.

The report produced by the explosion of the cartridges is so loud that it is impossible for anybody on the engine or in the front carriage not to hear it. This system has therefore the advantage not only of warning the driver himself of the presence of a stop-signal, but also the officials on the train, and travelers even; and, generally speaking, everyone who happens to be in the neighborhood when the train passes a stop-signal.

Therefore this system constitutes a safety device which is just as efficient, if not better, than a locomotive-cab signal. It has besides proved itself to be so, as there is no accident on record on the Orléans Railway due to a driver having passed a stop-signal in front of him.

FIG. 19.—*Ramp. Cousin Apparatus.*



Some Factors in Municipal Engineering*

The Role of Engineer in the Development of Municipalities

By Morris Llewellyn Cooke

THE role which the engineer is to play in the development of our municipalities will depend primarily upon the attitude taken by the profession as a whole toward what appears to be a wonderful present opportunity and also upon the ability with which the work of the engineer is brought to the attention of the public. There is no real reason why municipal engineering should not be made to comprise most municipal undertakings.

The test by which the role of the engineer is to be determined will be the development in our profession of a genuine spirit of public service. The community is apparently ready to accord the engineer a leading, perhaps a controlling part, if the engineer will consider that in every decision and act there shall be the clearest possible recognition of the public interest. We should remember that democracy can use the engineer without giving him either a leading or controlling hand in affairs. This use of engineers has been conclusively demonstrated by public utilities companies, especially during the last thirty years. In most of our larger cities during this period there have been operating one or more so-called "big business" men who have built large fortunes and a certain kind of fame in the development of enterprises in which engineering was an important factor and in which it should have been the paramount and controlling factor.

In these enterprises engineers have necessarily been used, but not in a leading or controlling capacity. As a profession we may as well face this problem and decide whether in the further upbuilding of our cities, we are to serve democracy as to be warranted in demanding and to be entitled to receive a position comparable to the real importance of our work.

Difficult as it is for some to realize it, democracy will not ultimately be deceived. In the long run democracy's sense of values is unerring and that profession which considers only its own and its clients' interests without a proper regard for those of the general public will be accorded the same position which history has always given those who are led by no higher star than self interest, however enlightened that self interest may be.

These suggestions out of my personal experience are offered in a spirit of the fullest optimism. I firmly believe that the engineering profession is rising to meet its broader responsibilities with perhaps an even more quickened pace than that which during recent years has wrought such sweeping changes in the medical profession and that of architecture. As with everything that is worth doing, however, our course is fraught with dangers.

There are certain kinds of engineering in which financial and almost all other kinds of preferment depend on an attitude of mind which, while not necessarily anti-social, does not provide sufficient opportunity for entertaining a virile public point of view. As a representative of public, rather than private interest, it is my duty in choosing the advisers of the city which I have the honor of serving to satisfy myself not only as to the ability of those we employ, but also as to their disinterested—yes, their public point of view.

No matter how able a man may be, how broad his experience nor how high his standing, his service to those who employ him must at all times be consistent with the public interest if, from my point of view, he is to be available for public employment.

Judged by this standard, there are in certain fields of engineering almost no engineers who are at present available for the service of the public and who at the same time have had sufficient experience for large undertakings. In the past few years we have had unusual opportunities for seeing at close range the professional attitude of those equipped with the technical knowledge required in advisers to cities on utility matters. It has been practically impossible to secure the services of those with reputations already made in the electrical field. Some of our experiences could be considered on the whole rather amusing were it not for the fact that we are left under the obvious conclusion that for the average city official to get good advice on these matters, is well-nigh impossible. What is more objectionable is that this condition is one quite generally recognized as true by city officials. We hear a good deal of complaint on the part of engineers that as a profession we are not chosen more frequently to serve on public service commissions and for similar technical work. Perhaps in our experience may be found at least part of the reason for this condition. Of course, when a city wants advice on a subject such as this the matter is usually one of considerable importance, often involving large sums of money, and in reaching conclusions the city official should not be dependent for advice on junior members of the profession.

I must be careful to emphasize the fact that no criticism of any individual is embraced in these remarks and that I am simply pointing out a danger almost necessarily confronting the engineering of an industry dominated by financiers having no knowledge and little appreciation of such professional standards as engineers are supposed to have.

The same tendency is to be noted in other branches of our profession. An eminent authority on concrete, who is in intimate touch with the men who are practising in this line, was recently asked for the name of an engineer who was not in any way affiliated with the large manufacturers of this material, and after considerable study was able to think of only one man. There is nothing necessarily improper in this situation—it may simply mean that all the competent men in this line receive retainers from manufacturers. Some months ago I wanted to retain an engineer fully posted on the details of a certain sub-division of railroad operation. It was extremely difficult to find a man without recognized affiliations which would preclude his retention. Again I am informed that there are no asphalt experts who do not receive retainers from the manufacturers. It is a condition which should be provocative of thought by engineers.

The conditions reflected in these statements are undoubtedly improving and as we recognize the dangers with which the very existence of certain branches of our profession have been threatened, necessary and remedial steps will be taken. But in any consideration of the opportunities afforded by the municipal field for engineers we cannot ignore such basic considerations.

I would not have you think that I do not fully appreciate that our present situation is the natural outgrowth of the fact that all of the foremost engineers have become prominent through the service of private interests. Public employers up to the present have been almost a negligible factor in furnishing opportunity for employment or for the making of a reputation. It is perfectly natural, and it is in accord with former ideals that engineers should feel their first duty to be to these private employers. But in this time of broader and deeper social consciousness, it seems to me that this standard must change.

The point I wish to make is that engineering has now reached the stage of development where it has become a profession in the highest sense of the word. The engineer being a scientist, his responsibility should be for the development of facts, regardless of whose advantage they may serve. I have in mind that the service of an engineer should be as the service of a judge and as opposed to the service of a lawyer who confessedly seeks out and represents the interests of his client, and often "makes the worse appear the better cause." This is justified by the fact that lawyers are not scientists, and by the assumption that there shall always be opposing counsel.

In the medical profession during the last generation, largely owing to the enlightened leadership of the American Medical Association, there has been inaugurated a great forward movement with the slogan of "preventive medicine." The medical profession in a way seemed to launch a campaign to wipe out its opportunity for a livelihood. There were, and I suppose still are, doctors who held that in advocating "preventive medicine" the profession was standing in its own light. The profession, however, is held in higher esteem than ever before. Under the new conditions there is a broader field for the activity of practitioners, both medical and surgical, than had ever before been available.

On the contrary, in inviting the attention of our profession to the municipal field, we are apparently opening the door of opportunity to tens of millions of dollars worth of work which is not now either considered engineering nor carried on by engineers. The municipal field is almost virgin soil so far as engineering is concerned. As recently as ten years ago the problem of snow removal which is being discussed as a part of this day's programme, was so absolutely in the hands of thumb rule, and in many instances even of inexperienced men, that it is probably true that in no city in this country was it being attacked either by engineering methods or by engineers. Yet it will not be denied that on work of this kind, in which one city spent nearly $3,000,000 in six weeks last year, there is in reality an engineering problem of considerable magnitude.

If this municipal field is to be one in which engineers of ability, sincerity of purpose and high ideals are to find a permanent and satisfactory outlet for their energies, our profession acting as a profession will be one of the main agencies bringing about certain fundamental changes in the attitude of the public. In the minds of too many engineers, participating collectively in matters pertaining to municipal engineering means "getting into politics." Architectural work being a part of the business of the Department of Public Works in Philadelphia, we have had the co-operation of the American Institute of Architects and of its Philadelphia chapter from the beginning. We have made many demands on them and in every case have met with generous and enthusiastic response. This assistance has been entirely apart from the help rendered us by individual architects. We have had the constant, indefatigable and valuable support of the secretary of the American Society of Mechanical Engineers in our efforts to maintain the highest professional standards in the work of the department. But engineering bodies as such have given us no assistance and as far as I know have taken no part in the discussion of federal, state and municipal engineering, except in the matter of conservation, which for some reason is considered as innocuous from an engineering standpoint as a prayer-meeting.

Many municipal engineers in this country are beginning to adopt the European system of employing non-residents for certain highly specialized positions. Whenever this is practised it excites criticism and abuse. As yet no technical organization, so far as I know, has recognized the opening thus made for technical merit and given moral support to the movement. Again, I have tried to get support from organized engineers in the obviously necessary procedure of employing experts outside our regular staff, but without results.

From an engineering standpoint any scheme of highway construction which does not include an ample repair programme, is futile. In our community this is not at all understood because the plan has never been followed. It would seem a proper function of an engineering body to educate the community to this point of view. But, as a matter of fact, engineers as such have taken so small a part in public discussions that the layman with us settles more engineering questions than the engineers themselves and the taxpayer foots the bills.

The public to-day is undoubtedly impatient for "results." It has an unmistakable liking for the men who "do things." It has little patience for experimental work. There was introduced in our Philadelphia City Councils, an appropriation of $50,000, for an experimental test roadway and the bill was defeated on the ground that I had stated that the man who was to spend the money was one of the best experts on bituminous road-work in the country. It was held that this statement and the appropriation were inconsistent—that either the engineer was less expert than I had claimed or that we did not need an experimental test roadway. The title of the road in the appropriation bill was changed to read "service test roadway" and the bill was passed by a good majority.

The public must be taught that public service is not different from private service in that forward steps come frequently, even usually, as the result of a large amount of preliminary investigation. Again, the public, of which please remember we are a part, must be educated to place more responsibility on individuals, thus making it possible to do away with the great inefficiencies which inevitably accompany board and committee management. As long as we have boards and committees they will vote—and they will insist on voting—on matters that are not questions of personal opinion, but questions of fact which ought to be determined by the facts. It is one of our duties as technical men to carry on a propaganda which will show to the public the difference between these problems of policy and public interest, that are properly settled by public opinion and those scientific problems which are improperly settled unless they are settled according to the facts. Mr. Frederick W. Taylor, past-president of the society, in recent lectures has very forcibly and lucidly

* Presented at the Annual Meeting of The American Society of Mechanical Engineers.

suggested this fundamental difference. For instance, my opinion may be as good as that of any other citizen's as to how fast an automobile should be allowed to operate in different sections of a large city. The opinion of any member of this society is as good as that of any other citizen as to the penalty which should be inflicted for false registration. On the other hand, the designs for a bridge; or the specifications for a sewer; or the plans for the laying out of a public park; or the organization of the police department; or the fighting of fires; or the elimination of mosquitoes are necessarily the work of experts. Such work will always be indifferently done if done by voting; whether the voting is by the people at large or by a committee or board acting for the people. Notwithstanding all the boards and commissions that are created in the generally approved laws of to-day, there should be no uncertainty as to what questions they may vote upon. It is, therefore, one of the duties of the educated to carry this message to the people, and in doing so I do not think there will be any more powerful method than to give the great mass of the people a larger and larger knowledge of expert work.

Lord Kelvin is the authority for the statement that the physicist who has discovered some great principle or invented some new process in physics should be able to explain it to the first man he meets on the street—both what the discovery is and why it is useful; or failing in this he should go back to his laboratory and put in some more time. If Lord Kelvin could say this about discoveries in physics, surely our city officials and the public service engineers with whom they co-operate should take the position that their work is capable of being fully explained to those who are footing the bills.

Another difficulty confronting the engineer in public office is the restriction placed upon him in making proper expenditures. I have been given practically no money for purposes not contemplated by the City Councils at the time the appropriation was made. The result has been that whenever any emergency has come up it either had to be paid for out of private funds or we had to wait until the legislative machinery could be put to work to make the necessary appropriation. Every administrative officer occupying a position of wide range and responsibility, whether an engineer or not, should have a certain amount of money placed at his own disposal and guarded only by the necessity for ultimately explaining its expenditure. In requesting an appropriation of $10,000 for such unforeseen purposes, I agreed with our City Councils that if money were granted I would write a one-hundred word description of the purpose for which the money was used, such explanation to accompany each warrant drawn against the item. Even this does not go quite far enough, as my experience has shown. There are certain legitimate and necessary expenditures for expert services which should not be divulged for months after the expenditures are made. So that unless city officials are to be placed at a serious disadvantage in their negotiations with private concerns, certain moneys (representing, of course, a very small, almost negligible, percentage of the total appropriation) must be placed at their disposal for a more or less free disposition.

Experience has shown that in our department, spending as we usually do over $10,000,000 in a single year, for instance, we could profitably spend $25,000 a year for research and investigation work and for the employment of experts. Ninety per cent of the expenditures drawn against this amount could be explained on the vouchers as drawn. It would probably be wise to allow the remaining 10 per cent to be explained or not in the judgment of the administrative officer. This would only be following the practice followed in practically every city of the country in the expenditure of funds for the detection of crime.

Especially in engineering work almost the entire absence of what may be called a financial programme is the great handicap. Private institutions can go along for years on a straight operating basis and without the necessity for undertaking any extensive construction work. But a growing city—and all our cities are growing cities—must necessarily have to spend a considerable part of its income on construction. This can be done with intelligence only by taking a long look ahead. For instance, at the present time in Philadelphia we are facing expenditures of from $20,000,000 to $25,000,000 on a sewage disposal installation; perhaps $40,000,000 for rapid transit; with extensive additions to our water supply system, not to mention other millions which could profitably be spent on sewers, bridges, grade crossing removals and a much needed programme of modern highway construction. There is probably no city in the country that is even attacking this obvious business problem in an intelligent or energetic way. Reform will not be brought about until the community, and especially the business part of the community, is educated as to its necessity.

I am not one of those who feel that all our shortcomings are "the fault of the people." I would rather assume my share of the responsibility for conditions as they are and then join with my professional associates and the community at large in bettering them. If we engineers are to have any prominent part in this there are fundamental changes which we shall have to make in our own equipment for the work. In the first place, we have to get rid of the now old-fashioned idea that advertising is a crime. I admit that as a part of my work as a public official I put in a great deal of thought on what may be quite properly called advertising. By that I mean that I pay less attention in my reports to dignity of form and diction than to making them sufficiently interesting to be read. It is only as we engineers who are public officials learn to make the public, sometimes against its will, understand our work, that we are to get that degree of popular support for it which will make it possible for it to be done in an efficient manner.

In my opinion it is going to become more and more a necessity, not only in public but in private work, for engineers to be able to popularize what they are doing. It is true to-day that a man who wants to do really good and efficient work can do so only after an aroused public opinion. You cannot drive people in a democracy. So I admit that in offering employment to an engineer, other things being equal, I want what might be called a good advertiser. You can secure appropriations for work more easily when it is well advertised. The Panama Canal is a good example of this principle. Again, advertising is the best possible check against ill-advised expenditures. In building our Byberry and Bensalem Service Test Roadway we erected sign-boards on each of the twenty-six sections giving to the layman the exact method of its construction in non-technical language. If the public knows how a street is supposed to be constructed or cleaned, you do not require as many paid inspectors on the job.

The development of some varieties of municipal engineering is absolutely dependent upon the development of public opinion and must proceed with it. The matter of street cleaning is largely a question of an improved public taste in the matter of street paving. Unless streets are well paved they cannot be well cleaned except at a prohibitive cost. To jump from one degree of cleanliness in this respect, to another, without a supporting public opinion, may be enough to wreck an administration and to set the tide of civic improvement running in the opposite direction.

The newspaper is the great educator in these matters to-day. But we are already using in Philadelphia moving pictures, parades, and exhibitions. The possibilities of these and other means of publicity are not yet fully understood.

Again, more effort must be put into humanizing public administration. The engineer shares with those who have had the opportunity for education, the mistaken idea that the man at the top is in a position to tell the man at the bottom what is good for him. The fact that our country was founded and has been perpetuated on the contrary idea has not seemed to affect the situation very much.

Take, for instance, the movement which has led to the formation of large numbers of business men's associations and improvement associations. This affords one of the very best examples of the present vitality of American public life. Our leading men should accept them as something that has come to stay and co-operate with them in such a way as to direct their activities into profitable channels. It seems to me they afford the most promising agency through which, in the first place, the thought of the public on civic questions can be crystallized, and secondly, through which that thought can be given expression in definite public procedure. I have found these associations ready and anxious to hear from men who had definite knowledge on matters of public interest. It should be the attitude of any engineer who wants to play his part in the community, to affiliate with one of these organizations and to help to make it an influence. You can rest assured that the man who is in public life for his own personal advancement is bending every energy to defile and degrade these institutions and to divert them from the high mission which they have it in their power to carry out, so they need our help.

In such a discussion as this, one cannot ignore the civil service. It is always a pleasure to say that personally I could not hold public office if it were not for the safeguards and reliefs that our Civil Service Act affords. At the same time, without repeating what I have said in other public papers on this subject, I want to call attention to one fundamental misconception under which the entire civil service question in this country apparently rests. Civil service appears to be founded on the theory that the best man for the position will apply for it. I think it is the experience of every employer of men—and this is especially true in filling the higher positions—that the best man will not apply. On the contrary, you will usually have to go out on the scriptural highways and hedges to find the best man, and then having found him, fall on your knees and beg him to accept the positions offering such opportunities for public service and professional independence as are most likely to secure him.

This is the way to get good public servants. It is almost impossible to find men who have many of the qualifications for our work combined with a willingness to enter the public employ. Even if public employment should come to be considered more desirable than it is at the present moment, I think that this difficulty in finding the best man would still be encountered Therefore, if we are to have the highest class of men in important engineering positions we must develop some merit system by which the appointing officer is given a greater opportunity than he now has of finding *the* man for the job. In this work it is possible for our engineering societies to take an important part.

I believe, for instance, that if the secretaries of the four national engineering societies could be authorized by their several councils to associate themselves as a civil service board to act in an advisory capacity to federal, State and municipal service commissions, it would be a decided step in the right direction. Suppose the president of the Borough of Manhattan should want to secure a competent engineer to put in charge of the highway department. Through the New York City Civil Service Commission he would state the problem to this suggested advisory board, which in turn would appoint, say, three engineers to act as his counselors in finding the man. The appointing officer would keep these counselors in touch with the search, and when he was ready to make a choice, secure their approval before entering into a contract. In this way the merit system would act as a check against favoritism, but would allow the appointing officer the widest possible opportunity to search for the best man available. It would probably not be found desirable to have all of the counselors from the engineering profession and one of the engineers should probably be an expert in the particular branch of engineering to which the position to be filled belongs.

This procedure is a radical departure from the present idea of civil service, which is based on the assumption that it is impossible to allow the appointing officer to have anything to do with the selection of his men. Even under the most advanced forms of civil service the appointing officer is confined to a full statement of the qualifications he is trying to secure. One never exactly fills a position with just the kind of man in mind when the search started. It is a question of compromise and the appointing officer is the one who is in the best position to know where concessions can be made and which among the several requirements are the most indispensable. There would be no objection to a check on this action of the appointing officer through some kind of a written test. But to choose men for positions paying from $5,000 to $25,000 a year on the results of a written examination is absolute folly. So far as I know, engineers have never taken a hand in the discussion of methods under which engineers shall be chosen for positions in the public service, and it seems to me high time they should do so.

Now a word of warning about the growing complexity of municipal operations and administration. Gladstone, fifty years ago, described the then complexities of governmental administration in these words:

"A protracted experience of public affairs not unattended with a high estimate of the general diligence, devotion and ability of the Parliamentary as well as the civil servants of the Crown has long convinced me that of the more difficult descriptions of the public business, apart from the simple routine, it is only a small part that is transacted with the requisite knowledge, care and thoroughness. We have undertaken in the matter of government far more than ever in the history of the world has been attempted by the children of men."

If he had sounded this alarm in the year 1914 he would have made it very much more emphatic. Take, for instance, any city's inspection service. In industrial establishments it has come to be recognized as desirable not only to inaugurate a full system of inspection from the inception of the work, but to gather together under the direction of a single head as many as possible of those engaged on inspection work. In our cities at the present time we have a minimum of inspection and yet we already have in good-sized communities at least ten or twelve different officials who periodically inspect individual houses and places of business. For instance, we have building inspectors, fire marshals, police, meter inspectors, of several different kinds, water waste inspectors, health inspectors, elevator inspectors, truant inspectors, garbage and street cleaning inspectors. These men, for the most part, work so independently of one another that if, on a given date, representatives of each of these types

should call at the same house they might do so without any knowledge that the others had been there. In the Federal service it frequently happens that the Post Office Department, Treasury Department, War Department (and perhaps other departments), each starts a representative from Washington to a town on the Pacific coast on relatively minor commissions, simply because the business of the Government has become so complicated that it has become impossible for us to utilize our men and resources efficiently even though we desire to do so.

As compared with what has become good practice in the industries our record keeping in the cities falls far short of what it should be. Even with this meager quantity of records those that we have are practically unavailable except to those who make them. Unless some radical reorganization can take place and some sound system of record keeping can be evolved for governmental units, one is appalled at the chaos that will come within the next generation, as memory and public opinion give way further to the reign of records and facts.[1]

One distinct contribution which the group of engineering societies housed in this building can make to the solution of this question would be to establish in the Engineering Societies' Library a section devoted to a Municipal Reference Library. As a beginning a single alcove could be set aside under proper supervision and provided with the necessary index. There is every reason to believe that it would grow as rapidly as any other section of the library. At the present time there is no possible way for a city official to be sure that manuscript reports on engineering matters will be available twelve months after they are made. I have, for instance, a digest on American street cleaning methods prepared for our education by Day & Zimmerman, consulting engineers. It is an exceptionally valuable document. I know where it is to-day, but there is no possible machinery provided in Philadelphia or in any other city whereby officials can be sure that they can find such a report a few months after its preparation. This manuscript would be of very great value to any city official charged with the problem of extensive street cleaning. We would be glad to deposit this report in any library properly organized to receive it.

The same is true of literally dozens of reports on gas, lighting, electricity, garbage disposal, city planning, police discipline and others prepared under the present administration in Philadelphia. I know that, if this suggestion is adopted and such a library is started, city officials all over the country will be glad to have extra copies made of every report which should properly belong to such a library. In this way the results of the trouble and expense taken to study any one subject in one city would be made available for engineers interested in similar subjects all over the country. This agency could be started here at such minor expense compared with the value of the service rendered that I believe it is an obligation which our society can hardly afford to overlook, even though it should have to do it alone.

The more rapid promotion of municipal engineers due to moving from city to city, the development in our colleges and engineering schools of courses especially designed for those who want to follow this branch of engineering, the gradual but incessant cleaning up of city governments is going more and more to make municipal engineering a desirable calling. But nothing will go so far to remove the objections to municipal engineering as a career as the standardaization of all engineering specifications. Prior to this, of course, a tremendous amount of research work must be done. Much of this can be done by the cities themselves, but a large part of it should preferably be done by research laboratories. These latter may be connected either with existing technical schools or preferably be operated in municipal colleges founded sometimes in conjunction with existing colleges and universities as an aid in the great municipal movement.

Even a casual survey will show the municipal field not only to be a big one, but one in which relatively little work has thus far been done. I hope that these random notes of mine may be at least suggestive. The fact that we are holding this public service meeting to-day is proof positive that we are working in the right direction and that the engineers of the country are determined to play their part in the further upbuilding of this great republic.

[1] See Graham Wallis's "The Great Society," The MacMillan Company, New York, 1914.

The Coal-Tar Chemical Industry in Germany and America

THE coal-tar chemical industry includes not only the manufacture of dyestuffs, but of a number of valuable medicinal preparations, and of various high explosives. It is based upon the use of crude compounds present to a small extent in the tar obtained in the destructive distillation of coal in gas works and coke ovens. These 10 crude compounds—benzol, carbolic acid, anthracene, etc.—are separated from some 145 other substances present in tar, by fractional distillation. This is the work of the tar distiller. From the 10 crudes, nearly 300 more complex compounds, none of them dyes, are produced by highly refined and complicated chemical and mechanical processes, involving in most cases a number of complete chemical transformations. These serve as the materials for the manufacture of about 920 dyestuffs now in current use.

In the case of Germany, the domestic supply of "crudes" is amply sufficient. The color factories make all of the 300 intermediates required for Germany's own industry and a large share of those used in the very restricted production of other lands.

The industry has been chiefly developed by the inventive power of German chemists, combined with a wealth of technical skill and keen business management scarcely equaled in the history of any other branch of manufacture. The 21 German companies engaged in the dyestuff manufacture have a nominal capital of over $36,700,000, on which dividends average 22 per cent. Actual profits often reach 50 per cent. The great excesses have been devoted to new construction. It is the most remunerative industry in the empire, the one most solidly and formidably intrenched.

In the United States the supply of coal-tar is ample, sufficient to provide in abundance all of the crudes required for the manufacture of the dyestuffs consumed in the country. The amount of valuable by-products not yet recovered in our present coking plants amounts to $75,000,000 annually. With adequate provision to save all the benzol and tar liberated in American coke-ovens, enough of the 10 crudes could be secured to more than cover the world's consumption in making artificial dyestuffs.

If a commercial demand is present, American tar works can quickly provide all of the crudes needed, practically as cheaply as in Europe. In the manufacture of intermediates the production is restricted to four or five compounds, and these cover about one-quarter of the needs of American color works.

Our manufacture of heavy chemicals is well developed, able to expand rapidly, and supply all needed chemicals for the production of intermediates and their transformation into finished dyes.

The four establishments devoted to the production of dyes supply nearly 100 different colors, largely, however, as already stated, by "assembling" nearly finished products of foreign origin. These American firms are bold and enterprising, commanding about $3,000,000 capital, evidently doing the best they can under existing conditions to build up a national industry.

Investigation shows that their advance, beyond certain limits, in the manufacture of either intermediate or finished dyes is persistently checked and prevepted by the united action of German producers in underselling. The entire German color industry is so completely organized and accustomed to act as a unit in furthering the general interests, at home and abroad, that little success in facing their determined opposition has been obtained.

The present crisis has evoked deep interest on the part of all concerned—tar distillers, manufacturers of chemicals, manufacturers of dyestuffs, the many users of the same, and American economists in general—as to how the problem can be settled. There is no question but that our coke interests are ready to multiply their recovery plants for the production of benzol and tar, if a permanent market is assured. There is no question of the readiness of tar distillers to enlarge their plants for the production of an ample supply of the needed crudes if a continued demand is certain. American chemical works and American manufacturers of dyestuffs are ready to embark capital and experience in building up a distinctly American coal-tar chemical industry, using entirely American crudes and intermediates, provided there is adequate legislative prohibition against both "dumping" or unfair restraint of American trade by the arbitrary action of foreign monopoly permitted by foreign law and not as yet forbidden by our own. Domestic makers assert their ability to make at once over 90 per cent of the dyes now consumed in the United States, which are now patent-free, and state that the remaining tenth will soon be freed from patent restriction.

There seems to be a consensus of opinion that any rapid development and evolution of the dyestuff branch, on a scale commensurate with the nation's needs, present and prospective, can be assured only on the basis of an effective law preventing that action toward control of our markets by a foreign monopoly which is now prohibited to a domestic monopoly. Some of the largest manufacturers have personally informed the department that what is needed is not a tariff change, but laws placing a foreign monopoly on the same basis as an American one.

American economists feel that the present crisis offers the most favorable moment to decide upon a policy with regard to this one important industry, whether it is to be firmly rooted in American soil or whether the dependence upon a foreign source is to continue indefinitely. It is pointed out that each year elapsing increases in geometrical ratio the difficulties attendant upon any attempt to create a self-contained American dyestuff industry. Further, it is claimed that it is the only highly organized industry not yet brought on a broad and generous scale within the cycle of American economic activity.—*Report of Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce.*

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